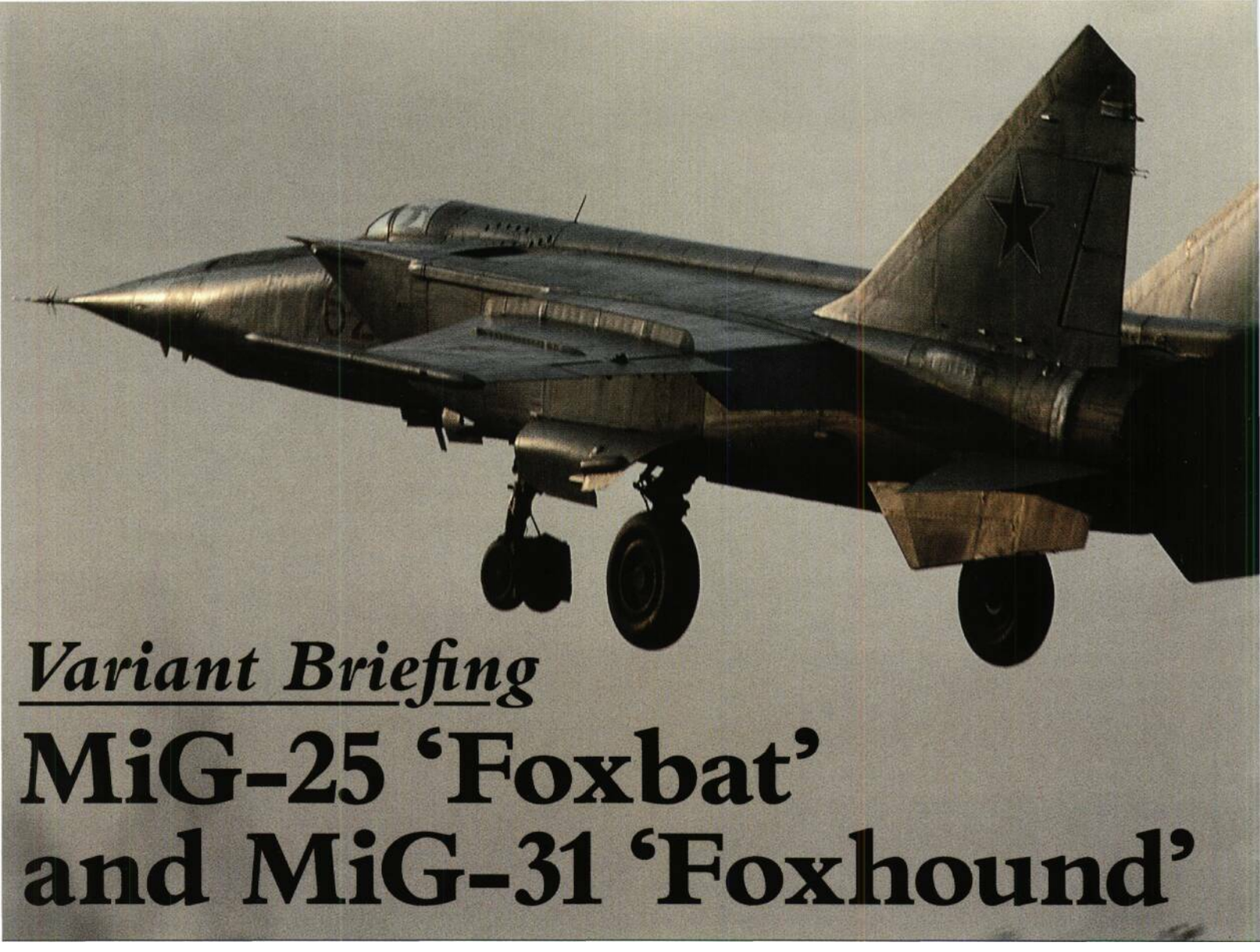


Variant Briefing

MiG-25 'Foxbat' and MiG-31 'Foxhound'

Along with Tupolev's 'Backfire', the MiG-25 'Foxbat' became a great symbol of the Soviet Cold 'War threat. The 'Foxbat' was never the superfighter it was once believed to be, but it had, and has, a surprising mix of complex and effective systems in a simple yet very capable airframe. The large family of 'Foxbat' variants was followed by the MiG-31 'Foxhound', a dedicated long-range interceptor; it had the misfortune to be born into the post-Cold War Russia and has thus died through lack of funding.

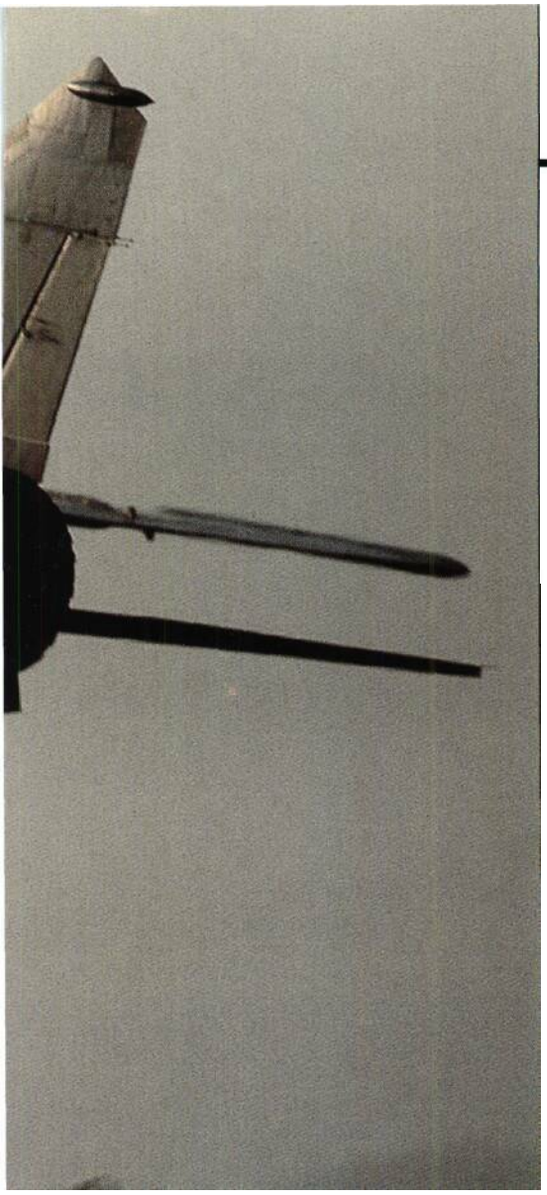
Above: The imposing size and rough shape of the MiG-25 set it apart from other combat aircraft. The 'Foxbat' is built from a unique mix of steel, aluminium and titanium alloys that gives it the structural strength to survive in its high-speed, high-altitude operational environment-yet is simple enough to be maintained on a flight line, in the rain.

Today, any member of the Western public with sufficient money to do so can pay for a backseat ride in one of the world's most impressive military aircraft. Theoretically capable of exceeding Mach 3, and of flying to an altitude of more than 80,000 ft (24384 m), the MiG-25 is a potent performer; however, today it is something of an anachronism, surviving in service in relatively small numbers, and is widely considered to be at the end of its career.

When the MiG-25 first appeared, it generated some panic among Western analysts, since it clearly represented a major technological leap in Soviet fighter development. The aircraft was extremely fast and many assumed that, as an interceptor, it would also have an astonishingly long range, a cutting-edge fire control system and a degree of agility. New aircraft taking shape on American drawing boards took account of the most pessimistic (and, as it turned out, wildly overestimated) guesses as to the MiG-25's performance. This erroneous baseline was even extrapolated forward to assume that, in the 1970s, the Soviet threat might be represented by an even more impressive development of the MiG-25, tentatively codenamed 'Fearless'. No-one knew what the MiG-25 was really capable of (except in terms of airspeed, after recce aircraft operating from Egypt were tracked on radar). In this 'information vacuum' there was a natural tendency to assume the worst.

The Belenko reassessment

After Lieutenant Belenko defected to Japan in his early model MiG-25 'Foxbat-A' in 1976, some Western analysts were astonished by what they saw as evidence of the type's inadequacy and crudity. Belenko himself revealed that the MiG-25 had an in-service limiting Mach Number of 2.5, and that beyond Mach 2.8 there was a tendency for the engines to 'accelerate out of control', and to 'overheat and burn up'. Reconnaissance 'Foxbats' tracked flying at Mach 3.2 over Israel during the early 1970s reportedly needed to have their engines replaced after such flights, though both this speed and the engine problem were explicitly denied by Russian sources. Despite its massive internal fuel capacity, the original MiG-25 fighter variant had (according to Belenko) a typical operational radius of action of less than 200 miles (320 km), limiting it to a one-pass attack. Early Western assessments had estimated the range at 1,240 miles (1995 km). Without external fuel the theoretical maximum ferry range was 1200 km (745 miles), though the service limit was a more modest 900 km (559 miles). Even the aircraft's much-vaunted high-altitude performance was less impressive than had once been believed. With only two missiles underwing, the 'Foxbat-A' was limited to 24000 m (78,740 ft), or to 21000 m (68,900 ft) with four. Although the MiG-25 could then fire its missiles in a 'look-up' mode, the weapons themselves were claimed to have been limited to an absolute altitude of 27000 m (88,580 ft) — said by some to be insufficient to cope with the highest-flying SR-71s. Moreover, the missiles were claimed to be too slow to catch an SR-71 at full throttle, and so were useless in a tailchase engagement, while the guidance system had problems coping with the very high closing speeds encountered in a head-on engagement. Nevertheless, despite the claimed low probability of success, the MiG-25 could theoretically cope with an SR-71 if everything went right. In the real world, MiG-25s did achieve lock-ons against SR-71s flying at operational altitudes, and a lock-on was impossible unless the target was within range, and speed,



Above: This is a line-up of MiG-25RBTs, the last production version of the reconnaissance/strike 'Foxbat-Bs'. The RBT retained the camera fit of earlier MiG-25RBs, mounted on a downwards-sliding pallet in the nose.

altitude and *g* were within the necessary limits. The SR-71s were never fired upon, but only because rules of engagement never permitted it. The MiG-25's deployment did effectively prevent the USAF from actually penetrating Soviet airspace on a routine basis. Although nominally a fighter, the MiG-25 was never really intended for fighter-versus-fighter combat and lacked agility. With full fuel in the wings, the pilot had to stick to a 2.2^ limit, and even at low weight, the aircraft was limited to about *5g.*

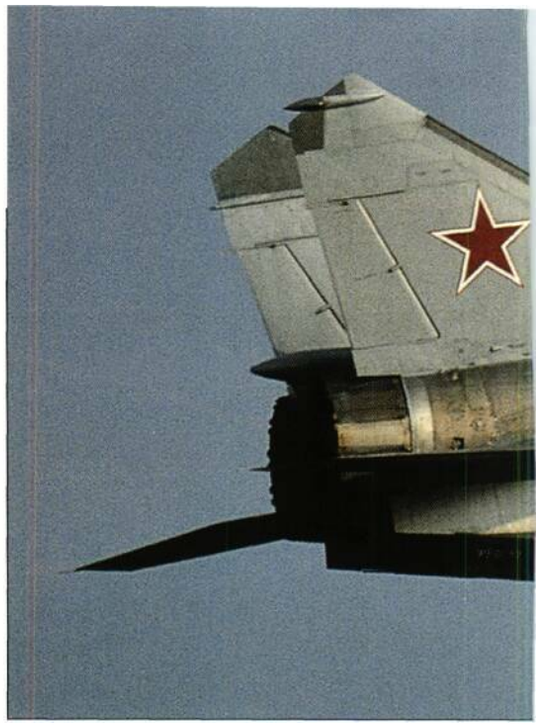
Seldom has an aircraft been assessed and reassessed more frequently than the MiG-25. What some saw as crudity others saw as positive features; e.g., where riveting was employed, the rivets were not countersunk, but they were used only in specific cases where they would not cause parasitic drag, and actually strengthened the structure. There were similar explanations behind other superficially archaic features. The 'primitive' valve-driven RP-25 Smerch (Whirlwind) radar, for instance, had sufficient power (600 kW at peak power) to 'burn through' hostile jamming. The avionics system's vacuum tubes represented the apex of that outmoded technology, and were more reliable and cheaper than contemporary transistors.

A probably apocryphal story suggests that pilots were banned from turning on the radar until after take-off, and that when this stricture was disobeyed, the radar was powerful enough to kill rabbits sitting by the runway edge. The radar (known as 'Fox Fire' to NATO's ASCC) was primitive, though, with virtually no look-down capability at targets flying below 500 m (1,640 ft) except over desert or a calm sea, due to ground clutter. The radar also had only limited range. The MiG-25P's radar detection range was limited to about 100 km (62 miles) against a bomber-sized target, with automatic tracking at ranges inside 50 km (31 miles), and the radar scanned an area of 120° in azimuth and 12° in elevation, centred about the aircraft's centreline. This was relatively unimportant, though, since the emphasis placed on GCI control meant that the onboard radar was used only in the terminal stage of an intercept, when the MiG-25 would almost inevitably be below its target. The need was to be able to overcome jamming by the target, and this the radar achieved admirably.

The basic reconnaissance version of the MiG-25 came in for similar criticism, based primarily on the fact that it had only optical cameras, with provision for a limited Elint package, while every SR-71 and U-2R was capable of accepting a much wider range of sensors, switching role by simply changing equipment in easily removable pallets or by changing whole noses. The MiG-25R philosophy was different, with a number of different single-sensor type variants. Some MiG-25s were equipped for photo reconnaissance (albeit with an Elint capability) while others were dedicated Elint or radar reconnaissance types (with a single vertical camera). These sub-variants would tend to operate together, in mixed squadrons. Moreover, all but the first reconnaissance

Below: The two-seat MIG-25U 'Foxbat-C' was a highly valued type. Serving as trainers, familiarisation aircraft and weather recce ships, the two-seaters saw more flying hours than any other MiG-25 version. This is a MiG-25RU with its clean wing - the MiG-25PU had pylons.

MiG-25 and MiG-31 variants



Above: This photograph of Victor Belenko's MIG-25P ('Red 31') at Hakodate is the best known 'Foxbat' image in the world, and a classic Cold War icon. In the face of extreme Soviet pressure, the dismantled MiG-25 was quickly flown out, aboard a USAF C-5 and JASDF C-1, and then shipped back to the USSR.

Below: This MIG-25RBT is one of a handful operated by the Bulgarian air force, because the USSR had no similar assets of its own based in that region. The 'Foxbats'flew high-speed 'race-track' reconnaissance orbits near the border, but the confines of Bulgaria's airspace eventually forced an end to their operations.

'Foxbats' could carry bombs for use in the high-speed high-altitude bombing role, a capability not shared by their Western counterparts. Although an individual reconnaissance MiG airframe might not have the flexibility of a U-2R, a squadron would have. As an example of this, the 931st ORAP at Werneuchen in East Germany included a squadron of 'Wild Weasel' MiG-25BMs, and a reconnaissance squadron which included three SLAR-equipped MiG-25s, five dedicated Elint platforms, one night photo-reconnaissance aircraft, and five aircraft capable of fulfilling photo-reconnaissance or Elint missions.

Strength, simplicity, sophistication

The aircraft could stand out in all weathers, operating from a flight line, and never needed cosseting in an air-conditioned hangar. The MiG-25 was extremely easy to maintain and service, demanding less specialised equipment and manpower than similar Western aircraft. There was provision for the extensive use of truck-mounted advanced automatic test equipment post-flight, .which the ground crew needed only to plug in. Fighter versions of the MiG-25 have an autopilot datalinked to GCI stations, allowing fully automatic intercepts. The powerful onboard computer has also attracted praise from Western analysts.

The MiG-25 is a uniquely Soviet aircraft, built to Soviet requirements and with the usual mix of good and bad characteristics. Just as the USAF has found it hard to replace its specialised SR-71s, there are some roles for which the MiG-25 remains unmatched. Moreover, while the American SR-71 was undeniably a hotter and more impressive performer than the MiG-25, it was less conventional, and much more difficult to support and operate on a routine basis. Arguably the most impressive thing about the MiG-25 was that its extraordinary performance was obtained in a relatively conventional aircraft, one which was simple and cheap enough to be produced in very large numbers and to be exported. Interestingly, the only confirmed Iraqi air-to-air kill of the 1991 Gulf War was scored by a MiG-25, which downed a US Navy F/A-18 Hornet, and MiG-25 reconnaissance aircraft can still operate with impunity over many parts of the world.

Moreover, the MiG-25 formed the basis of the two-seat MiG-31 interceptor, an aircraft whose excellence has been largely hidden by the present sad state of the PVO. The MiG-31 has been handicapped by lack of funds, and has picked up an undeserved reputation after a spate of accidents, all of which have been the direct result of a restriction in pilot flying hours. Production of the MiG-31 'Foxbat' has now ceased, while procurement of the (probably inferior) Su-27PU (Su-30) has continued, thanks mainly to Sukhoi's greater political clout.

Although there is some argument as to the relevance and effectiveness of the MiG-25 and its derivatives today, there is no doubt as to its Cold War conception.

'Foxbat' genesis

When Francis Gary Powers's U-2 was shot down by a SAM over Sverdlovsk on 1 May 1960, the writing seemed to be on the wall for the idea that high-altitude performance could provide any immunity from interception. In fact, development of a further high-altitude reconnaissance aircraft was already well underway, and this (which became the SR-71) proved that reduced radar cross-section and very high speed capability, combined with high-altitude performance, could be sufficient to overcome the SAM threat. It was calculated that an aircraft flying at Mach 3.5 above 65,000 ft (19812 m) could not be intercepted, while a Mach 3.2 aircraft could only be intercepted below 80,000 ft (24384 m). Even then an SA-2 would have a ground range of only about 10 miles (16 km), and could probably be defeated in the terminal phase by energetic manoeuvring.

An SR-71-type threat had to be countered. More than security of secret installations or national pride was at stake. A bomber version of the Blackbird could not be ruled out (and it later emerged that such a variant, the B-12, reached an advanced stage), and an interceptor would clearly have to be developed to cope with the threat. Meanwhile, even in the USA, the assumption was made that an SR-71/B-12-type capability could be developed by the enemy, and the YF-12 interceptor was developed. Moreover, the USSR's own reconnaissance aircraft faced a similar SAM threat to those of the USA, and it was realised that a very high-speed, high-altitude platform could function in the reconnaissance and interceptor roles.

It would be an over-simplification to suggest that the MiG-25 was no more than a panic response to the SR-71 or its precursors. Development of what became the MiG-25 began four years before the A-12 first flew in 1962, and two years before Russia became aware that the A-12/SR-71 programme was underway. In fact, the driving force behind the MiG-25 was initially the development of the Convair B-58 supersonic bomber, and the various even more advanced bomber projects known to be taking shape on American, British and French drawing boards. Knowledge of the

trisonic XB-70 Valkyrie had a major influence on the MiG-25 programme, of course, since the new Soviet fighter suddenly had to be able to deal with a Mach 3 target - rather than a B-58 flying at a mere Mach 2.

For many years, the Soviet air defence organisation, the IA-PVO (Troops of the Air Defence), was something of a poor relation within the Soviet air forces. The technology did not exist to produce a comprehensive and integrated air defence system for the entire USSR, and the network of S-25 SAMs and manned interceptors was used mainly for the point defence of specific cities and major military installations.

The success of the S-75 (SA-2) against Powers's U-2 led to the dominance of the SAM, and a number of longer-ranged, more heavily armed interceptor projects were terminated. In the USSR the idea that all manned fighters were obsolete never fully took hold, and fighter development continued. This resulted in the deployment of the huge Tupolev Tu-128, significant mainly for its 2500-km (1,553-mile) range, its long-range missile armament and long-range radar. While the Tu-128 clearly represented a superb defence against aircraft like the 13-52, its relatively slow speed (1665 km/h; 1,000 mph) was not sufficient for it to be terribly effective against aircraft like the B-58 Hustler or A-5 Vigilante. The Mikoyan OKB began serious work on heavy, long-range, very high-performance interceptors during the late 1950s, initially scaling up its successful MiG-21 configuration to produce the various 'big MiGs' - the 1-75, Ye-150 and Ye-152. Though unsuccessful, these types played a crucial role in exploring the high-speed high-altitude regime, in developing the concept which lay behind the MiG-25, and even in encouraging the development of suitable weapons and avionics systems. The MiG-25 represented a major leap forward even from these advanced aircraft, however, and Mikoyan's decision to proceed with the project was seen by some within the bureau as being akin to picking up a poisoned chalice. The decision prompted something of a schism in the highest levels of the OKB, leading to the resignation of Anatoly Brunov. As a result, the ailing Gurevich took his place, and the MiG-25 became the last true MiG, worked on by both of the bureau's founders.

The MiG-25RBF 'Foxbat-D', which appeared in the early 1980s, had two small dielectric antenna panels on the underside of the nose instead of camera ports. RBKs were converted to RBFs at WS maintenance facilities. This example is carrying the massive 5280-litre (1,161-Imp gal) ventral fuel tank, unique to the 'Foxbat'.

The Ye-155 prototypes

Always sensitive to charges of 'copying' Western designs, official historians maintain that the Ye-155 configuration was a 'clean sheet of paper' design, though there are persistent reports that the project began life after the 1959 Paris air show, when Artyom Mikoyan instructed his then-chief designer, Selctskii, to produce an interceptor "along the lines of the Vigilante." In fact, the preliminary design department under Rostislav Belyakov (later general designer of the OKB, and the man credited with designing the MiG-29) produced three quite different configurations, one with engines staggered vertically, one with tandem engines (the front engine exhausting amidships) and one with side-by-side engines. The team also explored the use of variable-geometry wings, and the provision of lift-jets for STOL operation. Some configurations had two crew, usually in tandem.

The MiG-25RBF was the final development of the camera/Elint-equipped MiG-25RBs and was based on the MIG-25RBK. The RBF had no provision for cameras, replacing them with the Shar-25 (Balloon-25) Elint system.

The directive issued by the Council of Ministers and the Central Committee in February 1961 ordered Mikoyan to develop the Ye-155P *(Perekhvatchik* — radar-directed) as an interceptor and the Ye-155R *(Razvedchik]* for reconnaissance. MiG's designs were always intended to be multi-role aircraft.

Another directive was issued by the Council of Ministers and the Central Committee in early 1962, outlining in some detail the operational requirements, authorising prototype construction and laying down the expected test and construction schedules. Even before work on the prototype began, a relatively large number of testbed

aircraft were flying with elements of the MiG-25's intended equipment fit. The R15B-300 engine's immediate predecessor had clocked up considerable flight time (as the Rl 5-300 and R15F-300) in the Ye-150, Ye-152 and Ye-152M, including flight at high speeds and high altitudes, while the definitive R15B-300 was extensively tested below a Tu-16LL. Meanwhile, a MiG-21 served as a testbed for the Polyot navigation system. The programme was also supported by a small fleet of converted airliner types. One of the Tu-110 prototypes served as a testbed for the R-40 missile's semi-active radar homing guidance system, while a Tu-104 tested the Smerch-A (ASCC 'Fox Fire') radar, its new pointed nose gaining it the nickname 'Buratino' (Pinocchio). Two more Tu-104s flew with the main computer, the Anis INS, the Tropic and Peleng navigation complexes and the Strela Doppler.

Meanwhile, the GAZ-21 aircraft factory at Gorkii (now Nizhny Novgorod) prepared for production, gaining new equipment for working with the new materials to be used in the production of the MiG-25, and refining production techniques and processes. The prototype aircraft took shape in the OKB's own workshops, which were known as the Zenit Machinery Works, in an attempt to maintain security and secrecy. The Gorkii factory eventually built 1,186 MiG-25s between 1969 and 1984, with production peaking at a rate of 100 per month. Interceptor production for the VVS and PVO ceased in 1979, when the MiG-31 entered production. Thereafter, small-scale fighter production continued for export, while production of reconnaissance versions also continued. Four more 'Foxbats' were built in the OKB's own workshops, bringing the total production to 1,190.

The essential powerplant

The definitive Ye-155 was designed around the only available engine — the Tumanskii R15B-300, derived (but extensively redesigned) from a powerplant designed for use in a UAV. There were other suitable engines but they were still on the drawing board, or were earmarked for other applications. The engine designers quickly replaced the simple hydromechanical fuel metering valve of the UAV engine (optimised to keep the engine at constant power) with a fully variable electronic fuel control unit (the first on a Soviet combat aircraft), and provided an adjustable-area nozzle for the afterburner. The afterburner was probably the largest augmentor ever produced up to that time, and required 12 actuating rams. Modifications were made to the compressor and combustion chamber. The engine was never as robust as engines designed from scratch for manned aircraft applications, and early MiG-25s entered service with engines certificated for a 150-hour life. The earliest R15B-300s were even less durable, with a quoted life of 25 hours; it was eventually extended to 750 hours.

The definitive R15BD-300 is a single-shaft axial-flow turbojet, with annular combustion

These 'Foxbat-Ds' are seen at a Russian Arctic base, in June 1994. Serviceability levels of the MiG-25 fleet are questionable, though, today, the reconnaissance variants are bound to be more prized than the interceptors.

This Swedish air force photo of a MiG-25 BM over the Baltic harks back to the days when 'Foxbats' were regular photo subjects for Flygvapnet Drakens and Viggens. Today intercepts of Russian aircraft are virtually nil.

MiG-25BM 'Foxbat-F'

The MiG-25BM (Izdelye 02M) 'Foxbat-F' was developed specifically with the European theatre in mind. It was the 'Wild Weasel' defence suppression MiG-25, specially developed to carry the Kh-58 (AS-11 'Kilter') anti-radiation missile. The prototype (a rebuilt MiG-25RBV) first flew in 1976, but introduction into service was slow. MiG-25BM production lasted from 1982 to 1985, and fewer than 100 were built.

ECM adaptations
The MiG-25BM had an extended nose to house its new EW and emitter detector systems. It had an antenna fit that somewhat resembled the MiG-25RBK.

Kh-58 (AS-11 'Kilter')
The Kh-58 was the first Soviet-developed anti-radiation missile that could be easily carried on an aircraft smaller than the Tu-16 or Tu-22. The Kh-58 was designed for tactical aircraft and was incorporated into MiG-25 design concepts from an early stage (the same is true also for the MiG-31). The Kh-58 has a launch weight of 640 kg (1,410 lb), is 4.80 m (15.75 ft) in length and 38 cm (15 in) in diameter. The warhead is understood to be a 150-kg (330-lb) HE blast/fragmentation unit, and some sources have suggested that a small nuclear warhead can be fitted. The Kh-58 uses intertial mid-course guidance and then passive radar-homing. It has an estimated maximum range of 70 km (44 miles) from low altitude, and up to 150 km (93 miles) from high altitude.

'Wild Weasel' 'Foxbats'
Though the high-speed and high-altitude performance of the MiG-25 offered it considerable protection from SAMs, an air defence suppression version was developed to make doubly sure. It was a fast attack aircraft, very difficult to engage and shoot down. Initial designs such as the Ye-155K and the MiG-25RB-derived MiG-25B were not followed through. Instead, the all-new MiG-25BM dedicated SEAD version appeared. The MiG-25BM (and its associated weapon system the Kh-58) had a troubled development period and only entered service in 1988, several years after production had actually ended.

Camouflage measures
To disguise the true role (and revised mission fit) of the MiG-25BM, service aircraft wore false grey-painted radomes in an attempt to resemble the MiG-25PD interceptor. The MiG-25BM lacks the ogival radome of the MiG-25PD and has a distinctive triangular 'bump' under its more pointed nose.

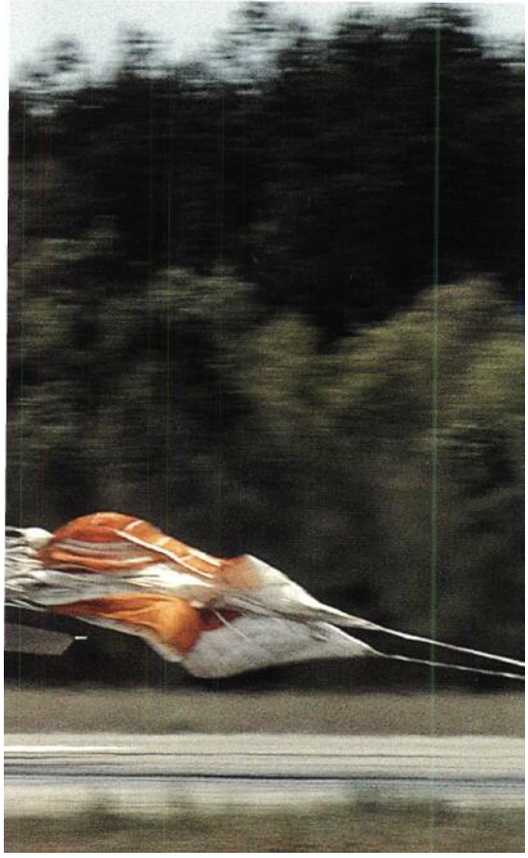
Left and below: A handful ofMiG-25s based in East Germany (like some SukhoiSu-25 'Frogfoots' also) wore a rough camouflage pattern referred to, in the West at least, as an 'Afghanistan scheme'. The 'Foxbat'saw little or no action in Afghanistan. This MIG-25RBK (left) is seen at Werneuchen, in April 1991. This MIG-25RBS (below) is now active at Akhtubinsk, the Russian air force operational trials base.

chambers, a single-stage turbine and a three-position ejector. The engine was rated at 73.33 kN (16,534 lb st) in dry power, or 109.83 kN (24,691 lb st) with full augmentation. Maximum exhaust gas temperature was 820°C (1,510°F) in flight, or 20°C lower on start-up. Each engine had a separate fire indication system, with ionisation sensors and separate CFC fire extinguishers.

The engines were mounted side-by-side in the rear fuselage, but were separated by a longitudinal' firewall. Their mountings were attached to fuselage bulkheads 10 and 11. The engines were mounted rotated through 13°, so that the underslung accessory gearboxes were canted outboard, away from each other. The engine nozzles are so close together that they would have overlapped if the three innermost nozzle segments had not been removed to allow the installation of a narrow boat-tail fairing which incorporated the mounting for the tailcone and brake chute compartment.

Advanced systems provide electrical and hydraulic power, pressurisation and air conditioning. Early model MiG-25s had a single-phase AC system, but later aircraft had a three-phase system with two circuits supplied by engine-driven SGK-11/1.5KIS-M 200-215-V (400-Hz) generators. DC power (28-Volt) was provided in separate circuits by two GSR-12KIS generators and 15SCS-45B silver-zinc batteries. The MiG-25 had two independent hydraulic systems, one (the booster system) powering one cylinder of each of the flight control boosters, and the emergency wheel brakes. The general system supplied the second cylinder of each flight control booster, and also operated the landing gear, flaps, airbrakes, normal wheel braking, air intakes, emergency landing gear retraction and nosewheel steering, together with some other minor services. The booster system contained 30 litres (6.6 Imp gal) of silicon-based hydraulic fluid, with 53 litres (11.7 Imp gal) in the general system. The systems were powered by engine-driven rotary-piston, variable discharge pumps at between 2,570 and 3,000 psi (180-210 kg/cm^2). Each system was powered by two pumps, one driven by each engine. The air conditioning system used bleed air from the engine compressors at 16 psi (1.2 kg/cm^2) cooled from 400°C (750°F) and fed either to the cockpit sub-system or to the avionics bay sub-system before being further cooled. The cockpit air conditioning system uses 240 kg (530 lb) of air per hour, at -7°C (20°F), with the avionics bay taking 560 kg (1,234 lb) per hour at -20°C (-4°F). Cockpit temperature can easily be maintained at 20°C (68°F).

For the Ye-155, Mikoyan Gurevich abandoned the traditional nose-mounted 'pitot' intake that had been a hallmark of the bureau's earlier fighters. This made it easier to accommodate a large search radar, and allowed the fuselage length to be kept shorter. Instead, the engines were 'fed' by individual rectangular intakes mounted on the fuselage sides, sharply raked and fitted with moveable ramps to control shock wave formation and regulate airflow into the engines. Each intake duct also incorporated



Above: The MiG-25's brake chute is housed in a bullet-shaped canister between the two engines. The fairing is made from Tekstolit, a cheap resin-based composite material, like Bakelite. The chute is activated on touch-down, by a sensor in the port ventral fin.

Right: 'Foxbat' pilots typically wear a Gsh-6 pressure helmet with a VKK-6M full pressure suit, for high-altitude operations. They can also be kitted out with a VMSK-2M/4 immersion suit, ASZh-58 lifejacket or Komplekt-L NBC suit.

a water/methanol injection system 'tree', which could spray water/methanol directly into the compressed air (reducing its temperature and volume) before reaching the compressor face, and thereby increasing mass flow while holding down turbine temperatures.

The fuselage was a one-piece monocoque structure built up around 14 main bulkheads (No. 1 level with the leading edge of the windscreen, back to Nos 13 and 14 supporting the stabilator mountings) with frames and stringers. Lower longerons and beams added further strength and rigidity. The pressurised cockpit and avionics bay sat one atop the other between bulkheads 1 and 2. The centre fuselage between bulkheads 3 and 12 was one enormous fuel tank, which formed the main load-bearing part of the fuselage. A welded steel (SN-3, VNS-2, VNS-4, and VNS-5 alloys) structure, this tank carried more than 10 tonnes (9.8 tons) of fuel and was augmented by integral tankage in the wings. Total fuel capacity was 17760 litres (3,906 Imp gal). This included 2810 litres (618 Imp gal) in the first fuselage tank, 3220 litres (708 Imp gal) in the second, 3060 litres (673 Imp gal) in the third, 2340 litres (514 Imp gal) in the fourth, 2370 litres (521 Imp gal) in the fifth, and 730 litres (160 Imp gal) in the sixth. Front wing tanks held 550 litres (120 Imp gal) each, with 1910 litres (420 Imp gal) each in the rear wing tanks. An accumulator tank held a further 150 litres (33 Imp gal), and fuel lines accounted for another 40 litres (8.7 Imp gal). The reconnaissance aircraft also had fin tanks, each holding 600 litres (132 Imp gal).

This tankage amounted to a 14570-kg (32,120-lb) fuel load for the interceptors, and 15000 kg (33,068 lb) for the reconnaissance versions. A very high fuel fraction was essential if the aircraft was to be able to sustain supersonic flight for any reasonably prolonged period. Single-point pressure refuelling was incorporated.

The MiG-25 made extensive use of steel in its construction, since kinetic heating at high speed forbade the use of conventional aluminium alloys. A MiG-19 flying at Mach 1.3 in air at 0°C (32°F) would experience skin friction which could increase the nose temperature to 72°C (161°F), while a MiG-21 flying at Mach 2.05 in similar conditions might reach 107°C (225°F) around the nose. Conventional Duralumin could withstand 13()°C (266°F), but calculations indicated that a Mach 3 aircraft could easily experience 300°C (572°F). There was little experience of using titanium (which was in any case prohibitively expensive, prone to cracking and notoriously difficult to work), and the use of fuel-cooled aluminium structures would have required the extensive use of heat-resistant sealants, which would again have represented something of a 'leap in the dark' in the USSR. Moreover, the Soviet aerospace industry was suffering from a shortage of skilled riveters, while workers skilled in welding were plentiful. Steel was cheap and simple to work with, and could be welded (making production easier and cheaper). The material confounded the expectations of pessimists, who believed that steel structures would be too prone to crystallisation and stress-cracking. Soviet metallurgists developed new high-strength, heat-resistant steel alloys, which were used with conspicuous success.

In the end, some 80 per cent of the MiG-25 airframe was of steel construction (SN-3, VL-1, VNS-2, VNS-5, EI-703, and EI-878 alloys), with titanium alloys (OT4-1) accounting for another 8 per cent, and 11 per cent being of heat-resistant D19T aluminium alloy. The engine bays each incorporated heat shields coated with a 30-micron layer of silver (5 kg/11 lb per aircraft), which absorbed 5 per cent of the heat and represented a more cost-effective solution than gold or rhodium, though these metals were

tested. Fifty per cent of assembly was by argon arc welding (more than 1,400,000 spot welds), 25 per cent by bead welding (3960 m/ 13,000 ft), 1.5 per cent by fusion or inert gas welding, and 23.5 per cent by conventional bolts and rivets.

In almost every area, conventional materials proved inadequate in the extraordinary range of conditions in which the MiG-25 would operate. Conventional hydraulic fluid decomposed (or boiled) at very high temperatures, while acrylic plastics used for conventional cockpit canopies, normal tyre rubber, and a host of other routine materials had to be replaced or modified. At full speed, the MiG-25's canopy actually becomes far too hot to touch, a graphic illustration of the kinetic heat generated.

Such high temperatures demanded advanced cooling equipment as well as high temperature materials, of course. The MiG-25 was therefore generously provided with heat exchangers, turbine coolers and refrigeration units.

Wing and fuselage layout

The trapezoidal wing had a compound sweep leading edge, with 42° 30' at the wingroot, and 41° outboard on the interceptors, and a constant sweep of 41° 02' on the reconnaissance variants. The wing had a straight trailing edge, and was optimised for low drag between Mach 2 and Mach 3. Relatively light, yet stiff, the wing incorporated a significant quantity of fuel tankage. It was built up around a conventional box structure, with two main spars attached to the No. 7 and No. 9 bulkheads, a front spar attached to the No. 6B frame, and two rear spars attached to bulkheads Nos 10 and 11. The wing had inboard plain flaps, with two-section ailerons outboard, and with a fixed titanium leading edge housing fuel lines and cable runs. The flaps and ailerons were of Duralumin construction, with honeycomb cores. On early aircraft, the flaps were blown to improve take-off performance and to reduce landing speeds. Like many Soviet combat aircraft, the MiG-25 had two chord-wise fences above each wing, the inboard fence stretching across virtually the whole chord at the aileron/flap junction, with a smaller fence level with the junction between the twin aileron sections. Airbrakes were located above and below the rear fuselage, while an abbreviated tailcone between the engine nozzles housed a brake parachute (or more commonly after 1977, a pair of brake chutes with a total combined area of 50 mV538 sq ft, since a single chute of sufficient area would have 'scuffed' along the runway).

Being shoulder-mounted above the lateral intakes and intake ducts, the wing gave adequate ground clearance for the carriage of very large underwing stores. This in turn dictated that the hydraulically actuated main undercarriage units be located in the fuselage, since a wing-mounted undercarriage would have required impractically long oleos. Complicating the designers' task was the need to provide the aircraft with a relatively wide track. In the end, the single-wheel main undercarriage units were made to retract forward, and were stowed vertically in the side walls of the intake ducts. The twin nosewheels also retracted forward, to stow below the cockpit. All three undercarriage units were fitted with pneumatically-actuated anti-lock brakes, while the pneumatic system (actually three independent sub-systems) provided emergency undercarriage extension and emergency intake actuation, plus power for brake chute actuation, canopy de-icing (which used ethyl alcohol), pressurising avionics and equipment bays, and fuel dumping. The steerable nosewheel had two turn limits for taxiing or for high-speed taxiing, take-off and landing.

The MiG-31 'Foxhound' has obvious MiG-25 roots but is a bulkier - and far more capable - interceptor. With its phased array radar and warload of long-range R-33 missiles, the 'Foxhound' is a formidable air defender.

The Ye-155 was initially designed with a conventional tail unit, with a single central tailfin, though it was realised that a single fin would have to be disproportionately large if it were to provide adequate longitudinal stability. The single fin was soon replaced by modestly canted (11°) twin tailfins, widely spaced on the upper 'corners' of the rear fuselage. They differed from one another and were not interchangeable. Interestingly, while the MiG-25 went from a Vigilante-style single fin to twin fins, the A-5 itself had originally been drawn up with twin fins. Initially, the MiG-25's tailfins were augmented by finlets on the wingtips, and by huge ventral fins under the fuselage. The tailfins each had a single-piece rudder actuated (like the other flying controls) by irreversible twin-cylinder boosters. Each booster was simultaneously fed by both hydraulic systems, one system going to each cylinder. The horizontal tail surfaces consisted of massive slab tailerons, whose leading edges were swept at 50°.

The original MiG-25 was originally designed for the interceptor and reconnaissance roles, and was subsequently adapted for the SEAD role. Variants are divided into these three role-based families, with a separate section detailing the distinct family of MiG-31 variants and precursors. The MiG-31 was based on the aerodynamic configuration of the MiG-25, but featured a new structure, systems, avionics and engines, and was a much later aircraft optimised to meet the threat posed by air-launched cruise missiles. The MiG-31 brought the MiG-25 right up to date, and the type's present moribund status reflects the political and economic realities of the new Russia, rather than any shortcoming of the aircraft itself. **Jon Lake**

Left: This is one of the follow-on production batch of improved MiG-31B/BS 'Foxhounds', fitted with a retractable refuelling probe. The MiG-31B/BS also has a superior avionics and radar fit.

Right: 'White 903' is a bureau-owned MiG-31 which has worn the blue and white scheme applied to several demonstrator 'Foxhounds'. This aircraft may well have been involved in the MiG-31E export version programme.

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MiG-25 and MiG-31 Variants

Prototypes and early projects
Unbuilt projects

While Mikoyan's preliminary design department struggled to define a configuration for the bureau's new fighter, a huge number of designs were examined and discarded before the definitive configuration was finalised. The Ye-155 had the misfortune to be born as attention was being focused on the need for STOL capability in tactical aircraft, and as a result swing-wing and lift-jet variants of the Ye-155 were briefly examined. The Ye-155R (VG) featured swing wings very much like those fitted to the General Dynamics F-111, merging with the horizontal tail when fully swept to form a virtual Delta. The aircraft was envisaged as a two-seater, but the weight penalties of the new wing and second cockpit were unacceptable, making the type's enhanced low-speed manoeuvrability and short take-off distance unaffordable luxuries. The Ye-155R (lift-jet) was no more successful, but for the record featured Rybinsk (Koliesov) RD36-35 lift-jets staggered (starboard slightly forward) on each side of the spine. The lift-jets imposed an unacceptable weight and range penalty, since they took up space otherwise allocated for precious fuel. All early reconnaissance projects were envisaged as two-seaters, though their profile was almost identical to that of the MiG-25RB as built. This was because the navigator sat submerged in the forward fuselage in front of the pilot, with no view of the outside world except through a pair of small side windows and via a sighting periscope.

The basic Ye-155R was to be optimised for high-altitude reconnaissance, using speed and altitude to keep it safe from enemy defences. To fulfil a medium-altitude reconnaissance role, it was believed that unmanned drones would have to be used. To carry such a drone, the preliminary design department drew up the Ye-155RD. It would have carried an RPV which was to have been configured with either cameras, night cameras, LLTV or SLAR, and which could have transmitted information back to the mother ship, which itself had photo-reconnaissance and Elint capabilities.

More frighteningly, the aircraft was seen as a potential strategic missile carrier. The Ye-155N *(Nosteel-* mother ship) defined in 1961 was developed in parallel with the Ye-155RD but was soon abandoned. Further cruise missile-carrying studies were made almost 20 years later, during the late 1970s.

Despite its inherent unsuitability for low-level operations, the Ye-155 was even examined as a potential low-altitude fighter-bomber, under the designation Ye-155Sh, and as a dual-role fighter-bomber/tactical reconnaissance aircraft as the Ye-155ShR.

Between 1963 and 1965, Mikoyan studied a five/seven-passenger supersonic business jet (or urgent cargo) derivative of the Ye-155. It was designed to operate from unpaved runways and had an extended, widened forward fuselage and a conventional enclosed cockpit. The final configuration had six single seats in line abreast, with an aisle and an entry door forward on the port side, immediately aft of the cockpit. The aircraft had four-wheeled main undercarriage bogies and was designed to cruise at Mach 2.35, and had sufficient fuel for a range of about 3000 km (1,875 miles).

Above: The Ye-155R was a lift-jet-equipped STOVL version of the initial Ye-155 design. It was not compatible with the mission requirements.

Below: A five- to seven-seat supersonic jet transport was the most extraordinary of all the proposed Ye-155 designs.

Above: The swing-wing Ye-155R reconnaissance concept would have had a navigator's station in the nose (note small windows).

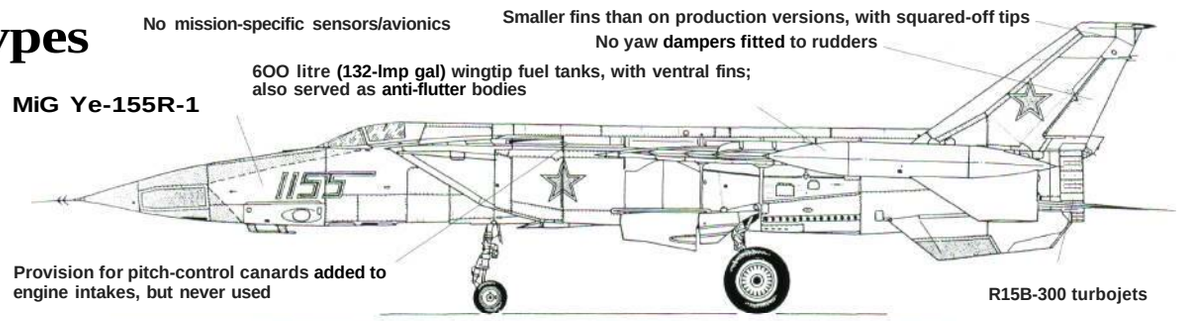
Ye-155R prototypes

The reconnaissance prototype (Ye-155R-1) emerged before the first interceptor. Built in Mikoyan's own workshops, the aircraft was trucked from Moscow to Zhukhovskii in December 1963, where it eventually made its maiden flight on 6 March 1964, in the hands of Alexander Fedotov. The prototype had an aerodynamically correct reconnaissance nose, but this was empty of operational equipment. Ballast and test instrumentation also replaced the ECM equipment, navigation suite, and even the HF radio. The aircraft had a wing with no incidence and no anhedral, instead having a 600-litre (132-Imp gal) fuel tank on each wingtip.

The flight test programme revealed lateral instability at transonic speeds, with a tendency for the aircraft to make an uncommanded roll which could not be countered even with full aileron deflection. Fuel sloshing back and forth in the wingtip tanks caused excessive vibration to the wing, while stability was inadequate at maximum speed, afterburners tended to blow out, and the intakes suffered from turbulence at high Mach numbers and high angles of attack. The ventral fins tended to scrape the runway, and were soon reduced in depth. The wing was redesigned with 2° of incidence and 5° of anhedral, but the anhedral was not introduced immediately, and many early pre-production aircraft flew with distinctive triangular endplate fins instead.

The second prototype was built without wingtip tanks (which were removed from the first aircraft) and incorporated various minor modifications. The second aircraft may have been the first with the slab tailplane modified to be capable of differential operation at high speeds, for roll control. By the end of the prototypes' flight test programme, the only major problem still to be addressed was that conventional paint, hitherto used without any problems, tended to blacken and blister at very high speeds reached by the Ye-155R.

With the factory tests completed (after some 200 flights), the next step was State Acceptance Tests, for which a larger number of more fully equipped aircraft would be required. Accordingly, four pre-production aircraft were ordered.



Left and below: The Ye-155R-1 wore a four-digit 'tactical' code ('Red 1155'), reflecting its status as the first Ye-155. It is seen here at Zhukhovskii, fitted with the large tip tanks that were later removed after stability problems.

Ye-155R pre-production

With the OKB's own workshops busy building the MiG-23-01 and MiG-23-11 'Flogger' prototypes, it was left to the Gorkii factory to produce the pre-production reconnaissance 'Foxbats'. This caused some disruption, but did ease the transition to full-scale MiG-25 production.

The first pre-production MiG-25 was Ye-155R-3, which differed from the reconnaissance prototypes primarily in having a full daylight camera and a broadly representative avionics fit, rather than an aerodynamically representative nose. The nose structure was revised slightly to accommodate real equipment. The aircraft carried A-72 and A-70M cameras in oblique or vertical mounts, together with an A/E-10 topographic camera and SRS-4A (centimetric and decimetre wave radar) or SRS-4B Elint packs.

Avionics fitted included a Polyot 1L INS, Strela Doppler, and Orbita computer, together with a Peleng S navigation system. The aircraft also featured 2° of incidence on the wing, while the distinctive wingtip tanks and finlets were replaced by slender fairings incorporating anti-flutter weights. The tailfins were increased in height and had angled tips, with tail-mounted antennas relocated accordingly. Finally (like all but the first production interceptor aircraft), Ye-155R-3 had provision for a huge 5300-litre (1,165-Imp gal) ventral fuel tank which stretched from the nosewheel back to the jetpipes.

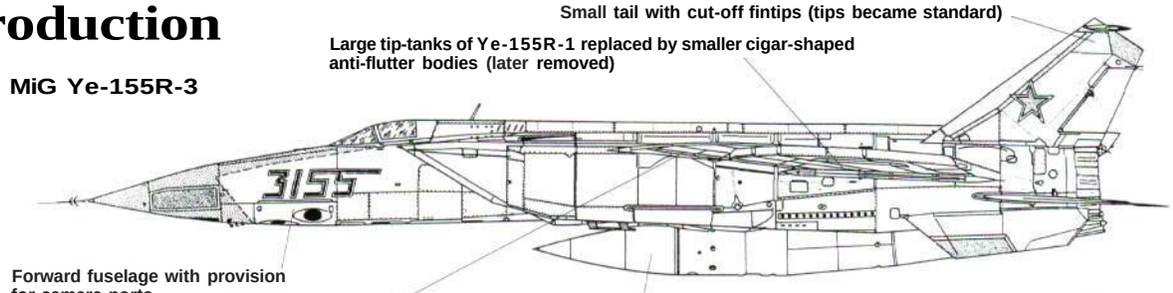
The second of the pre-production batch, Ye-155R-4, was representative of the intended production standard, and had the full avionics and navigation system. The final pre-production reconnaissance aircraft was the fourth, Ye-155R-6, though a fifth was produced for ground and static testing. Like the prototypes, the pre-production aircraft wore four-digit nose codes with their sequential number followed by 155. Thus, the pre-production batch wore codes 3155,4155, 5155 and 6155.

Such was the urgency of the Soviet air force's requirement for a new reconnaissance aircraft that the type was approved for production after an expedited and shortened development programme; the Peleng S suite still was regarded as being immature, the Polyot technically failed to meet air force reliability standards, and the loss of the Ye-155R-5 had yet to be fully investigated and explained. This aircraft crashed during its acceptance flight at Gorkii on 30 August 1965, injuring the pilot, Minenko. After trials at the LII at Zhukhovskii and the Nil at Akhtubinsk, the aircraft formally passed its State Acceptance Tests in 1967 and was cleared for full production with the signature of the Act of Acceptance in late 1969.

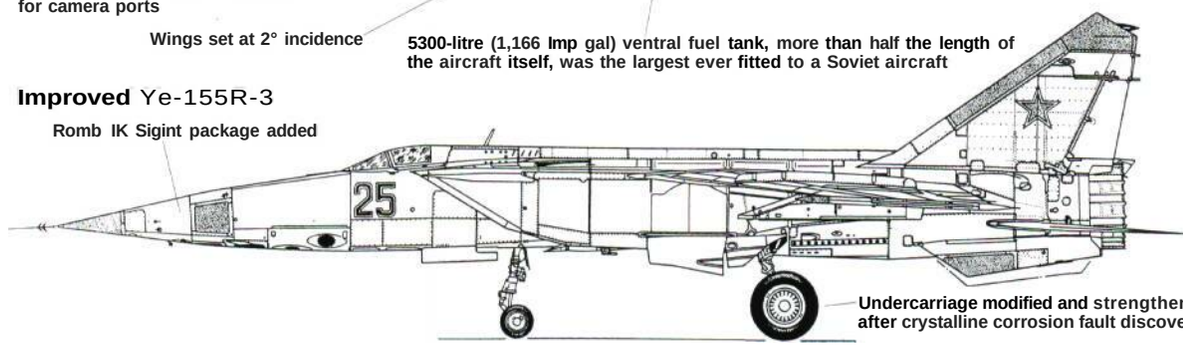
Remarkably, the Ye-155R proved to have few problems. The cameras were able to cope with the massive temperature changes in flight, while the flexibly-mounted camera ports remained rigid and produced no distortion even at high speed - when the MiG-25R's cameras turned in a resolution three times better than those of the Yak-27R, at 30 lines per millimetre.

Ye-155R-3 (together with three Ye-155Ps) made the type's public debut during a flypast at Domodedovo on 9 July 1967. Convinced that the type was already operational (or close to being so), NATO's Air Standards Co-ordinating Committee allocated the reporting name 'Foxbat' to the new fighter, which was erroneously pre-supposed to be the MiG-23.

MiG Ye-155R-3



Improved Ye-155R-3



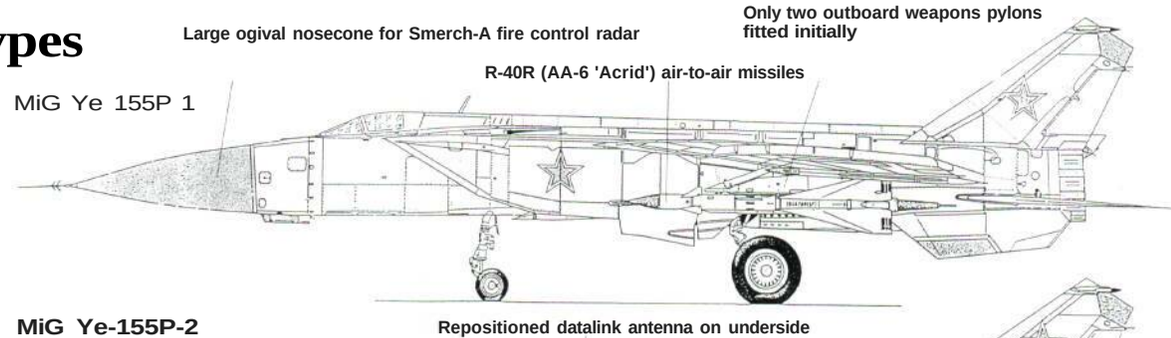
Left and below: 'Red 3155'was the first pre-production reconnaissance Ye-155 airframe. It had a full camera fit and undertook all the early systems testing.

Right: This is the Ye-155R-4 - the first MIG-25RB.

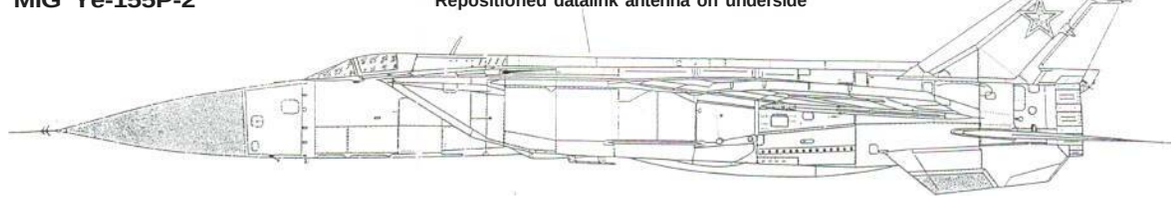
Ye-155P prototypes

Mikoyan built two prototypes of the fighter 'Foxbat', both based on the airframe standard of the Ye-155R-3, with tall tails and 2° incidence wing. The aircraft featured a new ogival nose radome, designed to accommodate the Smerch-A radar, though on the prototypes this housed test instrumentation and ballast. The P-designation suffix indicated *Perekhvatchik,* or interceptor. The first prototype had only two underwing pylons (outboard), each carrying a red-painted dummy K-40 missile. A datalink antenna (for telemetry) was fitted below the forward fuselage. The Ye-155P-1 made its maiden flight in the hands of Piotr Ostapenko, on 9 September 1964. The second prototype (Ye-155P-2) was similar, though the datalink antenna was repositioned further aft. Like the Ye-155R prototypes, the first two Ye-155Ps had fittings on the upper corners of the intakes to allow the fitting of canards, though, in the event, they were never flight-tested.

MiG Ye 155P 1



MiG Ye-155P-2



Ye-155P pre-production

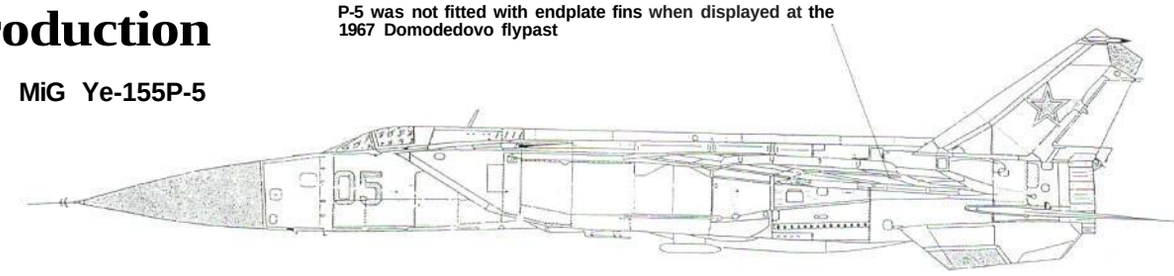
The more complex MiG-25P was part of an entirely new weapons system, and was not merely a new platform. State Acceptance Tests were anticipated to be wide-ranging and very searching, with the PVO expecting kill-probability statistics and other detailed data, and not just a simple 'tick in the box - it's OK for service'. The interceptor therefore required a bigger pre-production batch than did the MiG-25R, and a longer flight test programme. Accordingly, nine pre-production aircraft (Ye-155P-3 to Ye-155P-11) were built in Mikoyan's workshops, under fairly primitive and very cramped conditions. Most had the distinctive triangular endplate fins on the wingtips, even though they did have limited anhedral and incidence on the wings. The finished aircraft were too big to fit through the building's low doors, and had to be tilted to allow the tailfins to clear the door frames.

The Ye-155P-6 was the first of the interceptor 'Foxbats' to be fully equipped, with radar and operational avionics. The next three aircraft were similarly equipped and operated from Mikoyan's facility at Zhukhovskii, but the rest of the batch operated from the Nil WS test centre at Akhtubinsk. The majority undertook most of their flights with conformal belly packs containing test instrumentation.

While the problems suffered by the Ye-155R were minor, or were relatively easily solved, the Ye-155Ps had a rougher ride. The prototype and pre-production Ye-155Ps suffered a number of fatal accidents: Mikoyan test pilot Lesnikov crashed in Ye-155P-1 during a time-to-height record attempt on 30 October 1967, and the PVO commander perished in Ye-155P-11 on 26 April 1969. Specific problems included a dangerous level of asymmetric yaw and roll when one missile was fired.

MiG Ye-155P-5

P-5 was not fitted with endplate fins when displayed at the 1967 Domodedovo flypast



Above and right: Most of the Ye-155P development aircraft were fitted with large endplate 'flippers', referred to by the Russian engineers as 'webbed feet'. This is the fifth prototype, MiG Ye-155P-5.

Ye-266

The Ye-155R-1, Ye-155R-3 and Ye-155P-1 were used to set a series of FAI-recognised world records, some absolute, and others for C1 (III) class aircraft (jet-powered landplanes with an unlimited MTOW). The record-breaking flights were performed with a serious purpose in mind - of gathering information on stability, performance and systems performance at the extreme edges of the envelope (and indeed beyond the cleared service envelope). Official documents submitted to the FAI giving evidence of the record-breaking flights attempted to cover the identity of the aircraft type, using the spurious designations Ye-266 for the aircraft, and R-266 for the engines.

On 16 March 1965, Fedotov set 1000-km (620-mile) closed-circuit speed records without payload and with payloads of 1000 and 2000 kg (2,204 and 4,408 lb), reaching a speed of 2319.12 km/h (1,441.07 mph). On 5 October 1967 Komarov set an absolute 500-km (310-mile) closed-circuit speed record of 2981.5 km/h (1,852.67 mph). On the same day, Fedotov set altitude records with 1000-kg and 2000-kg payloads of 29977 m (98,350 ft). On 27 October 1967 Ostapenko set new 1000-km closed-circuit records with a speed of 2920.67 km/h (1,814.87 mph).

On 8 April 1973 more records were broken, when Fedotov set a new 100-km closed-circuit speed of 2605.1 km/h (1,168.78 mph). On 4 June 1973 Orlov took a time-to-20000 m (65,600 ft) record with a time of 2 minutes 49.8 seconds. On the same day, Ostapenko set records to 25000 and 30000 m (82,000 and 98,400 ft) of 3 minutes 12.6 seconds and 4 minutes 3.86 seconds, respectively. On 25 July 1973 Fedotov set altitude records with 2000-kg and 4000-kg (4,410-lb and 8,820-lb) payloads of 35230 m (115,585 ft) and an absolute record (with no payload) of 36240 m (118,900ft).

The final record was an incredible achievement, with Fedotov having to follow a closely defined computer-planned trajectory even though the engines flamed out well before the top of the trajectory (as expected) and even though the airspeed decayed to a low of 75 km/h (46 mph) with a very limited permitted range of elevator movement.

One of the aircraft, the Ye-133R-3, is now in the Air Forces Museum at Monino, with the spurious code 'Red 25', and with pylons from a MiG-25P. It had already gained the larger, production standard tailfins.

Additional records were set in 1977 by the Ye-266M, which is described with the production interceptor versions.

The Ye-155R-3 record breaker is now a resident at the Monino Museum. It was one of a trio of aircraft given the blanket designation 'Ye-266'.

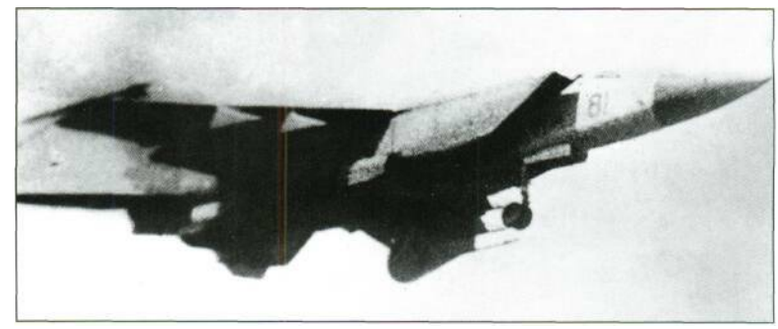
Production interceptor versions and their derivatives

MiG-25P (1-84) 'Foxbat-A', first production series

Although the Ye-155P-1 had flown in September 1964 (nine months after the reconnaissance aircraft), the MiG-25P was not certificated until 1970, and did not enter VVS service until 1973. Once the aircraft was cleared for service, its introduction was very rapid, not least since a backlog of aircraft had accumulated in the three years since mass production began in 1969. Surprisingly, the type enjoyed a relatively low accident rate, even though many of the first VVS regiments to re-equip with the MiG-25 used the aircraft to replace radar-equipped MiG-17s. This was a major jump in capability and performance, but the front line took the change in its stride.

The initial batch of production MiG-25Ps scarcely differed from the pre-production aircraft, sharing the same small tailfins and large ventrals, and featuring the limited anhedral wing with wingtip endplate fins. The aircraft were powered by the original R15B-300 engines, had the original RP-S Smerch-A radar, and lacked provision for a ventral fuel tank. They were delivered to the PVO Fighter Weapons School and a regiment near Gorkii from 1969, for training, tactics development and service testing. The aircraft were intensively used for test and practice firings of the R-40 AAM. Some sources suggest that the earliest aircraft carried AA-5 'Ash' missiles, but it cannot be confirmed whether these weapons were used in service. A handful of the earliest aircraft were subsequently rebuilt to incorporate later features, and some may eventually have been rebuilt as MiG-25PDs.

The MIG-25P officially entered service with the issue of a directive from the Council of Ministers on 13 April 1972.



The early production MiG-25 'Foxbat-As' had the same small tailfins, ventral fins and wingtip endplate fins as the prototypes.

MiG-25P (I-84) 'Foxbat-A* second/subsequent production series

When the MIG-25P entered full-scale production, the aircraft incorporated a range of changes, including the provision of larger tailfins and smaller (reduced depth) ventral fins. Wing anhedral was increased to 5°, and wingtip anti-flutter fairings with no endplate fins were fitted. The radar was the RP-25 Smerch-A1, which incorporated minor changes from the RP-S of the Tu-128 and was used in pre-production aircraft and the first production MiG-25Ps.

With the 'full-up' RP-25, the radar could search for or track targets autonomously, or by using inputs from ground-based radars, relayed to the MiG-25 over the Vozdookh-1 command link. Other data and messages were relayed from the ground to the aircraft using the Lazur datalink. Following lock-on, the aircraft could be flown to the launch point completely automatically, with the weapons' seeker heads being cued towards the target automatically.

The MiG-25 would then usually launch a salvo of two missiles, one an IR-homing R-40T, the other a semi-active radar homing R-40R. Thus, the four missiles carried by the aircraft represented only two attacks, with no extra offensive capability such as a gun or short-range 'dogfight' missiles. The missiles were carried on the Avtomateecheskoye Pooskoovoye Ustroystvo 84-46 (APU-84-46), meaning the automatic missile launcher for aircraft type 84 and missile type 46.

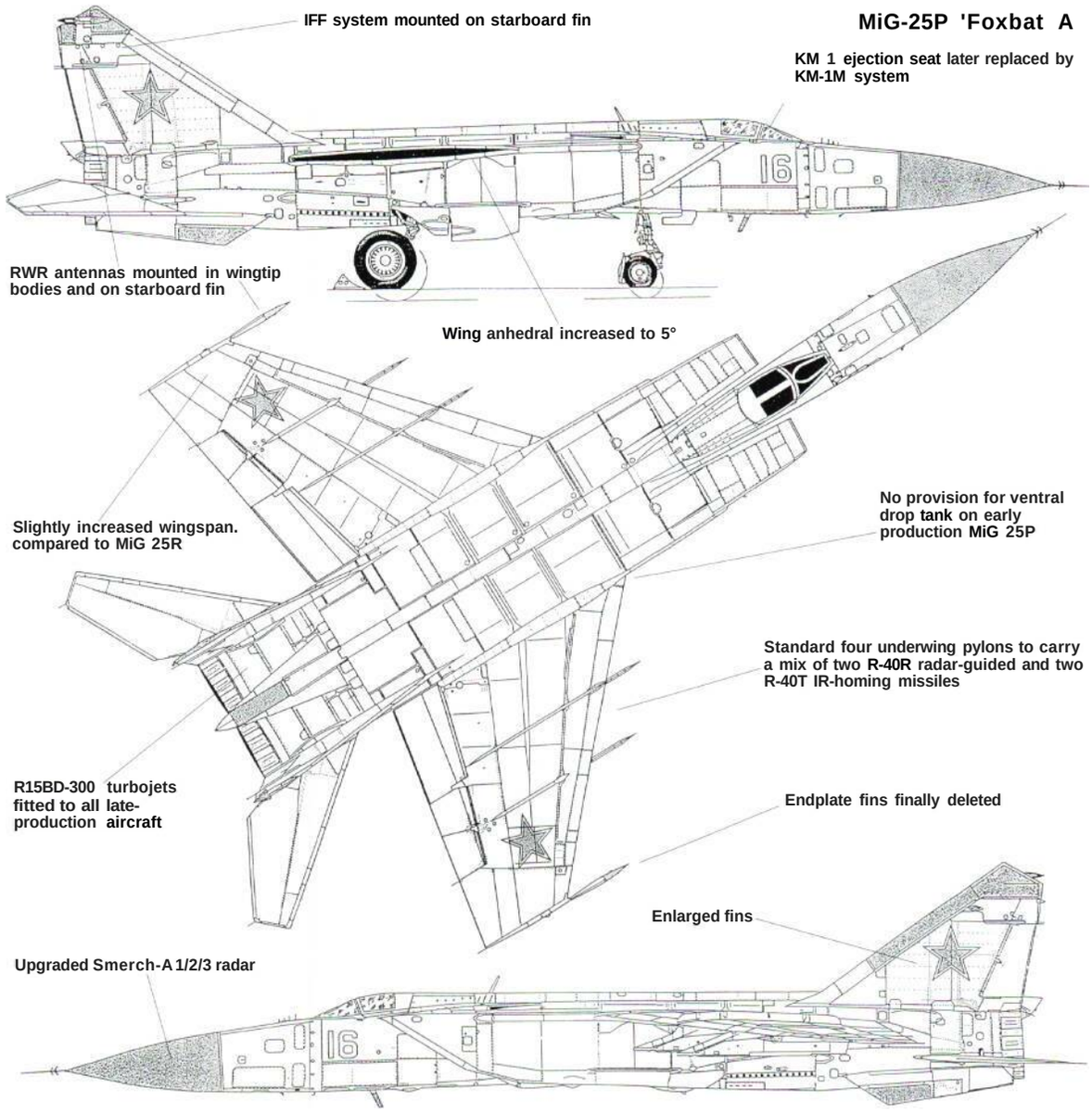
Other avionics systems fitted to the MiG-25P included a Sirena 3M radar warning receiver, an SRO-2P IFF transponder, and an SOD-57M or SO-63B ATC transponder. Communications equipment included an R-847RM HF radio, an R-802 Eukalipt or R-831 UHF radio and an SPU-7 intercom. The P-591 cockpit voice recorder incorporated an RI-65 tape recorder. The aircraft was fitted with RV-4 and RV-19 low- and high-altitude radar altimeters, an MRP-56P marker beacon receiver, SP-50 'Swift Rod' ILS, an ARK-10 or ARK-15 radio compass, and an RSBN-6S Korall SHORAN. The Polyot 1L operated in conjunction with ground-based DME and the onboard radar, and could automatically fly the aircraft (via the SAU-155P1 automatic flight control system) to a pre-set altitude and cruise speed, automatically following a route to and from the target with up to four turning points, and with automatic return to base or one of up to three pre-programmed diversion airfields, down to a 50-m (164-ft) decision height.

Quite early during the service life of the MiG-25, it was found that the rearward position of the tailplane pivot tended to lead pilots to overcompensate when backing off from, or stopping, a roll. A handful of aircraft (and pilots) were lost before the tailplane pivots were moved forward by 14 cm (5.5 in). All in-service aircraft were modified during a six-month period, aircraft being flown to strict limits prior to their individual modifications. All had been modified by the end of 1974.

During production of the MIG-25P the basic radar was replaced by the Smerch-A2, and later the Smerch-AS. A Smerch-A4 radar was developed but was never introduced, since it still had only the most limited look-down capability against targets flying against ground clutter. All variants of the Smerch radar featured a parabolic scanning antenna, and all were derived from the Tu-128's Smerch (ASCC 'Big Nose') radar. The MiG-25P's radars were known by the NATO ASCC reporting name 'Foxfire' or 'Fox Fire'. A tiny handful of later MiG-25Ps had provision for the huge centreline drop tank tested by the Ye-155R-3, while during the course of production the KM-1 ejection seat was replaced by the much-improved KM-1M seat. Rumours that a removable underfuselage gun pack could be provided eventually proved to be entirely unfounded.

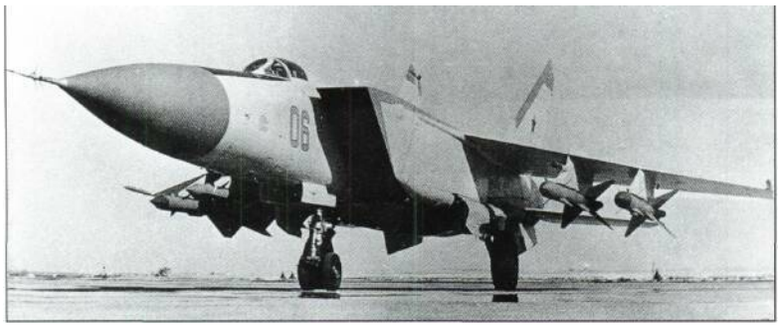
On 6 September 1976, a disillusioned PVO pilot, Lieutenant Victor Belenko, defected from Chuguyevka near Vladivostok, landing at Hakodate airport in Japan with only a few pounds of fuel left in the tanks. Belenko's almost new 'Red 31' (built earlier the same year) was returned to the USSR, but only after USAF specialists had dismantled it and examined it in the most minute detail, laying bare the aircraft's secrets. Belenko reportedly defected the first time he took off with full fuel for a low-level sortie, and defected to the West with his cockpit crammed with highly-classified technical manuals. Lieutenant Belenko's defection to Japan thus severely compromised the MiG-25, and provoked the development of a new variant with new equipment and technical features. This restored some of the aircraft's essential secrecy, and complicated the task of potential enemies who had thought that they knew everything about the aircraft. Although some MiG-25PDs were produced from new production, many were converted from MiG-25Ps, which rapidly began to disappear from service in their original configuration.

Some MiG-25s were delivered to export customers, but they were hybrid aircraft, part based on the MiG-25PD but with MIG-25P radar and systems. These aircraft are described separately.



Below left: This early-production MIG-25P was used for weapons test work.

Below: Today the only surviving MiG-25Ps are museum pieces, as all service aircraft have been upgraded to a higher standard.



MiG-25P (1-99) 'Foxbat-A'

The MIG-25P fulfilled most of its design requirements, but was always deficient in range. Over the years, the design bureau explored a number of options to increase range, any efforts being centred on the provision of more powerful but more fuel-efficient new engines. While the MiG-25M promised improved performance with a derivative of the existing engine, other projects used new engines which required some degree of structural modification to the MiG-25 airframe. The Izdelye 99 designation was applied to two aircraft (one, 'Blue 991', a MIG-25P; the second a MiG-25R, 'Blue 992') used as testbeds for the Soloviev PS-30F turbofan.

Derived from the Tu-134's 66.67-kN (14,99-lb st) D-30 engine, the afterburning D-30F or PS-30F was rated at 151.96 kN (34,170 lb st) with reheat, and had already been selected as the powerplant for the MiG-31. Some felt that a re-engined MiG-25 might be a useful interim fighter, replacing the MiG-25PD on the Gorkii production line until the MiG-31 was ready for production.

The two I-99s seemed to bear this out, demonstrating a subsonic range (clean) of 3000 km (1,865 miles), later 3310 km (2,057 miles) and a supersonic cruise range of 2135 km (1,327 miles). Service ceiling was raised to 21900m (71,850ft).

In fact, development of the MiG-31 proceeded more quickly than many had anticipated, and interest in the I-99 waned rapidly. The two I-99s were relegated to serve as engine development 'mules' in support of the MiG-31 programme.

MiG-25PD (I-84D) 'Foxbat-E'

The compromising of the MiG-25's secrets eroded its combat advantage, and it was quickly decided to install a new weapons- and fire-control system. The decision to develop a new variant was officially confirmed with the issue of a government directive on 4 November 1976, and a development programme was launched, with speed as the watchword.

Once the decision was taken to provide a new fire-control system, all new-build MiG-25 fighters were built to the new standard, under the designation MiG-25PD (*Dorabotannii* = modified or upgraded). The new variant retained many of the systems of the late MiG-25Ps, including an LO-06 Beryoza RWR, an R-864 HF, and RV-4A and RV-18 low- and high-altitude radar altimeters, while an SO-69 ATC transponder replaced the SO-63B fitted to early aircraft. Some of these minor changes were reflected by changes in the aircraft's antenna configuration.

Key systems were changed entirely. The Smerch-A radar was replaced by a new N-005 Sapfir-25 (RP-25M) set, based on the Sapfir-23 developed for the MiG-23 although with a larger-diameter antenna in the huge radome. The Sapfir name was associated with a succession of fighter radars, all of which used a twist-cassegrain antenna, from the 'Jay Bird' of the MiG-21 through the MiG-23's 'High Lark' and to the MiG-29's 'Slot Back'. The Sapfir-25 was probably based on the N-003 'High Lark 2' fitted to the MiG-23ML, rather than the earlier 'High Lark 1' of the MiG-23M and MiG-23MF. The radar scanned to 30° or 60° on each side of the centreline (depending on mode) and to 14° above and 14° below the centreline in elevation. The radar centreline could actually be displaced up to 56° in azimuth, and to 52° above or 42° below the nose. More vitally, the N-005 was a pulse-Doppler radar with a genuine look-down/shoot-down capability and a slightly improved detection range of about 115 km (71 miles). The new radar demanded provision of a new radome, possibly of composite construction, and sometimes appearing to have a distinct 'break' about halfway back, broadly in line with the forward face of the twist-cassegrain antenna.

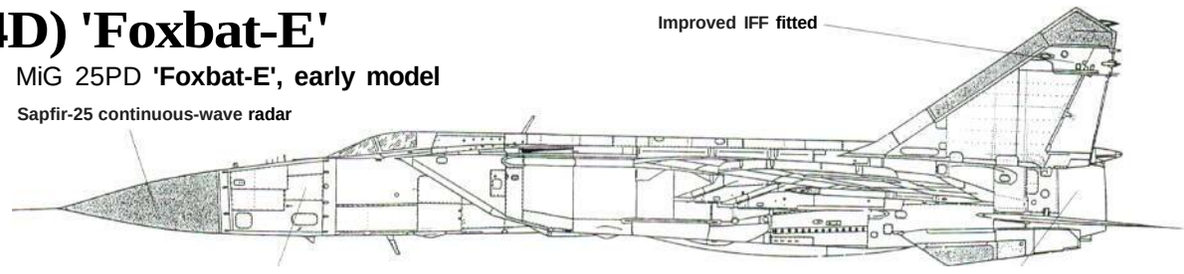
The new radar was augmented by a new TP-26Sh-1 infra-red search and track (IRST) system, which could detect, locate and acquire a target autonomously, out to a range of 45 km (28 miles). This allowed the MiG-25 pilot to intercept a target without using radar in heavy EW jamming or, if a stealthy approach was necessary, without alerting the target's RWR.

The R-40R and R-40T (I-46R and I-46T) missiles were upgraded with improved seeker heads for both SARH- and IR-homing versions, giving almost double the range. The new missile variants were designated R-40RD and R-40TD (I-46RD and I-46TD). For improved operational flexibility and greater combat persistence, the outboard pair of R-40s could be replaced by four R-60 or R-60M (AA-8 'Aphid') short-range IR-homing dogfight missiles.

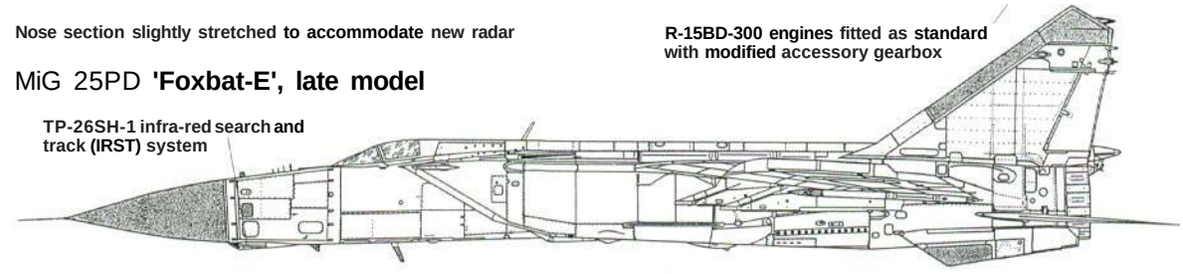
The MiG-25PD also introduced the new R15BD-300 engine. This had no change in thrust ratings (contrary to early intelligence reports), but featured modified accessory gearboxes. All MiG-25PDs had provision for the new centreline auxiliary fuel tank.

The Act of Acceptance formally confirming the MiG-25PD's service entry was signed in 1979. Among the operators of this variant were two regiments in East Germany, the 933rd IAP at Parchim and the 787th IAP at Finow. Known MiG-25PD construction numbers include 84042415 ('Blue 304') and 84037504 ('Red 74', based at Finow during the 1980s).

MiG 25PD **'Foxbat-E', early model**



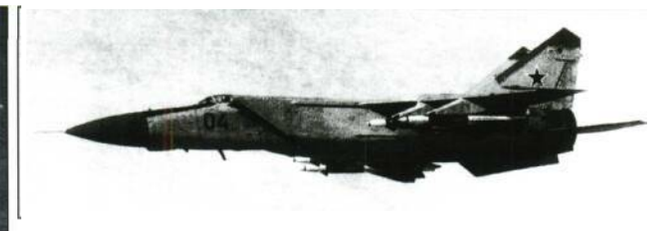
MiG 25PD **'Foxbat-E', late model**



Left: This is one of the MIG-25PD prototypes.

Above: The undernose Parol IFF antenna of the MIG-25P (as seen here) should not be confused with the IRST of the PD.

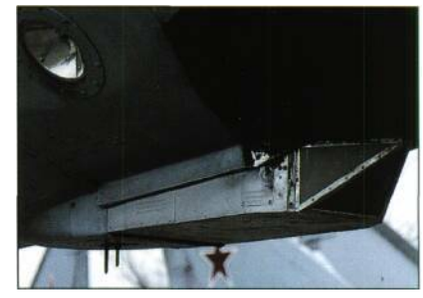
The cluttered cockpit of the 'Foxbat-E' was a challenging environment for a pilot running a high-speed, high-altitude interception.



Above: A Western intercept photo of a MIG-25PD with a full load of R-40 missiles.

Right: The MIG-25PD gained a TP-26Sh-1 IRST under the radome.

Below: A MIG-25PD seen in storage at Baranovichi air base, Belarus.



Export MiG-25P/PD 'Foxbat-E'

When the MiG-25's secrecy was compromised by the defection of Belenko, an obstacle to exports was immediately removed. Until Belenko's flight, exports of the top-secret MiG-25 were not considered - even to the Soviet Union's closest allies. After the aircraft's secrets were known to have been revealed to the USA, there was no need to keep the aircraft so guarded.

At the request of a number of Middle Eastern allies, an export version of the MiG-25 fighter was designed, loosely based on the MiG-25PD, but with some of the more sensitive equipment items and systems taken from the original MiG-25P, including the RP-25 Smerch-A2 radar, and probably the RWR and IFF. Most of the aircraft did have the undernose IRST sensor normally associated with the MiG-25PD, making the export aircraft 'Foxbat-Es' as far as NATO was concerned. Some Libyan MiG-25s have been photographed without the sensor, however.

Of the few export customers for the 'Foxbat-E', the Libyan air force was the most 'public'. This 'Acrid'-armed example was photographed by the US Navy.

The first exports were made to Algeria and Syria in 1979, with deliveries to Iraq and Libya following. Known Algerian aircraft (of 16 fighter and fighter-trainers delivered) include: 383, 386, 388, 389, 390, 392, 503, 689 (this last possibly a MiG-25RB). No Iraqi MiG-25 serials are known, although 20 fighter versions are believed to have been supplied. They were based at an airfield near Baghdad, where they formed two squadrons of a composite regiment, with the third squadron flying reconnaissance MiG-25s. The regiment had Soviet pilot instructors until December 1990, when its aircraft were quickly dispersed in a vain attempt to safeguard them from coalition air attack during Desert Storm. Of the 30 Libyan MiG-25 fighters, known serials include 806 (-A), 6716, 7003, 7029, and 7708. Syrian MiG-25 serials may include 808 and 4101. Again, 30 are believed to have been supplied.

The MiG-25 did see active service with some of its overseas customers. On 13 February 1981, a Syrian MIG-25P was ambushed by Israeli F-15s as it pursued a pair of RF-4Es. Later the same day, according to Russian sources, two F-15s were provoked into chasing a pair of Syrian MiG-21s, only to be 'bushwhacked' themselves by a pair of MiG-25s. The lead MiG-25 was shot down after it lost lock-on, but the second MiG-25 downed the second F-15 using two R-40s, fired from within 40 km (25 miles). The Iraqis had lost MiG-25s to Iranian fighters even before Operation Desert Storm, which was to account for many of the survivors. An Iraqi MiG-25P shot down a US Navy F/A-18 on 20 January 1991 (day two of Desert Storm), but at least two were lost subsequently to F-15s. More were destroyed in their hardened aircraft shelters. Following the war, Iraq lost another MiG-25 to USAF F-16s on 25 December 1992.

The export MiG-25s may have had their own internal OKB designation (perhaps MIG-25PDK), although this has never been confirmed.

This Libyan MIG-25P carries R-40 AAMs, plus smaller R-60 (AA-8 'Aphids') on its 'shoulder' pylons.

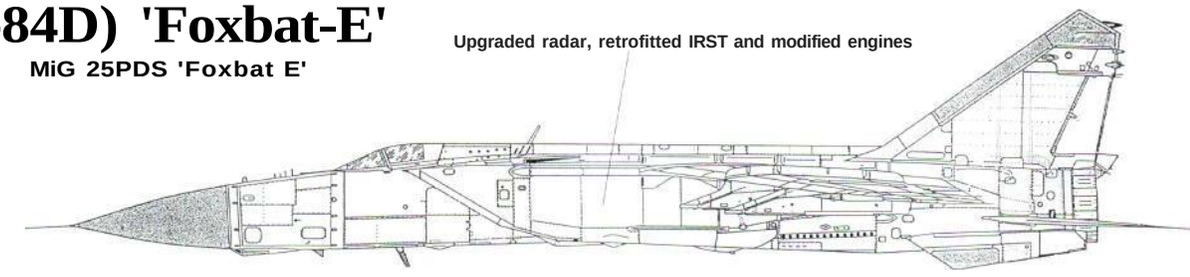
MiG-25PD (1-84-20) 'Foxbat-E'

During 1991 and 1992, a Zhukhovskii-based MiG-25PD was used as an engine testbed for a still-unspecified supersonic engine, probably in connection with the MiG 1.42 fighter programme. The engine had a much higher rating than the standard R15BD-300, and required a different intake control system.

MiG-25PDS (I-84D) 'Foxbat-E'

The success of the MiG-25PD with what was, in essence, a relatively simple modification, led to a programme to update all in-service MiG-25Ps to the same standards. Aircraft were upgraded from 1979, usually at the Gorkii factory during scheduled major overhauls. The modification involved the insertion of a small plug in the nose section, the new Sapfir radar replacing Smerch, and the new IRST being installed under the nose. The upgraded aircraft were also fitted with the new command link equipment of the MIG-25PD, and their engines were modified with new accessory gearboxes to become R15BD-300s. Modified aircraft were given a new designation of MiG-29PDS (*Dorabotannii v Stroyou* = field-modified). They were not given provision for the ventral fuel tank of the MIG-25PD.

MiG 25PDS 'Foxbat E'



Left: The PDS programme was a mid-life update for the MiG-25PD. All existing aircraft were modified, from 1979 to 1982.

MiG-25PDSL 'Foxbat-E'

A single MiG-25PD 'Foxbat-E' (and not a MiG-25PDS, as its designation would have suggested) was fitted with an experimental electronic countermeasures system pack in a semi-conformal ventral pannier, together with newly designed IRCM flare dispensers. Trials proved extremely successful, but it was thought that the new ECM gear could not be procured in sufficient quantities to justify retrofit to the whole fleet, and the MiG-25PDSL (*Letayuschchaya Laboratoriya* = flying laboratory) remained a one-off.

MiG-25PDZ 'Foxbat-E'

The USSR began air-to-air refuelling trials shortly after World War II, and Yak-15s, MiG-15s, MiG-17s and MiG-19s all undertook trials with a number of tanker types. Only a handful of tankers were acquired, and in service they were used only to refuel strategic bombers and very long range reconnaissance aircraft. The introduction of the Il-78M 'Midas' tanker and the development of the UPAZ-A buddy inflight-refuelling store held out the promise that more tanker assets might become available for tactical aircraft, and during the 1980s a number of front-line fighter and ground attack aircraft types underwent inflight-refuelling trials.

In the case of the MiG-25, a single MiG-25PD (coded 'Blue 45') was modified as an inflight-refuelling receiver testbed. The aircraft was fitted with an inverted-L shaped probe immediately in front of the windscreen, offset very slightly to starboard. The new probe was very similar to that fitted to the Su-24. It necessitated the addition of a short constant-section plug to accommodate the probe and its associated 'plumbing'. The probe was shortened after initial test flights, and a micro-control system was installed, allowing the pilot to make small corrections by differentially moving engine nozzle petals to slightly vector the engine thrust lines. The aircraft featured additional SHORAN equipment to help locate and rendezvous with the tanker, and was fitted with lights which could illuminate the extended probe.

The PDZ modification added a retractable refuelling probe to the nose of the MiG-25PD.

In the event, the PVO and VVS remained pitifully short of tankers, and priority was given to equipping newer aircraft types (the MiG-31, Su-27PU, MiG-29M and Su-27M) with probes, so nothing came of the proposal to retrofit in-service MiG-25PDs for inflight refuelling. Had a production installation been undertaken, the probe would probably have been moved to port, for commonality with the MiG-29 and Su-27.

MiG-25 and MiG-31 Variants

MiG-25M

The MiG-25's performance was always restricted by its R15B-300 engines, and early consideration was given to providing more powerful and more efficient engines. The most promising improvement lay in a fairly minor redesign of the existing engine. The new R15BF2-300 had an extra compressor stage, and new materials allowed hotter combustion chamber and turbine temperatures. This in turn led to an improvement in specific fuel consumption, a higher pressure ratio (rising from 4.75 to 4.95) and higher thrust. Dry thrust rose to 98.04 kN (22,045 lb st), with augmented thrust rising to 129.71 kN (29,166 lb st). The two engines shared the same dimensions and were installationally interchangeable, although the higher turbine temperatures necessitated some local heat-resistant treatment in re-engined aircraft.

This is one of the two MIG-25M testbeds, which flew with improved R15BF2-300 turbojets.

It was suggested that enhanced performance would require changes to the conventional airframe materials, including the radome, and the Duralumin forward fuselage, wingtips, ailerons and trailing-edge flaps. The development programme for the new type was split into two distinct parts, one testing and refining the new engine, and the second proving and testing the necessary structural modifications.

For the engine tests, Mikoyan used two aircraft - one a MiG-25RB (coded 'Blue 601'), and the other a MiG-25PD ('Blue 710'). The MiG-25PD flew for the first time on 12 June 1973, and then flew with the R15BF2-300 engines on 30 August 1973.

The re-engined MiG-25s demonstrated a useful improvement over the basic MiG-25, but production of the R15BF2-300 promised to be difficult. The PS-30F-engined advanced MiG-25s, the MiG-25P/I-99 and MiG-31 showed equal promise, yet offered even better fuel economy. The first test aircraft was used to set a number of world records under the designation Ye-266M, finally being grounded in 1977; the second aircraft (by then fitted with MiG-25R-type wings) was also withdrawn from use earlier that year.

Ye-266M

The Ye-266M designation was used for a MiG-25M testbed used to set a number of performance records. The aircraft ('Blue 601', built as a MiG-25RB) was flown by Fedotov and Ostapenko to set three time-to-height records on 17 May 1975. 25000 m (82,020 ft) was reached in 143.2 seconds, 30000 m (98,425 ft) in 189.85 seconds, and 35000 m (114,830 ft) in 251.7 seconds. On 22 July 1977, Fedotov used the same aircraft to set an altitude record of 37080 m (121,653 ft) with a 2000-kg (4,408-lb) payload, and set an absolute world altitude record of 37650 m (123,523 ft) on 31 August 1977.

MiG-25PA (Ye-155PA)

The MiG-25PA was drawn up in the mid-1960s around the advanced Smerch-100 radar (which later became the MiG-31 's Zaslon) and R-100 missiles. The aircraft was designed for even higher speeds and altitudes (4000 km/h; 2,500 mph and up to 30000 m; 98,425 ft) but was abandoned when requirements changed and increasing emphasis was placed on performance against low-flying targets.

MiG-251

The MiG-251 (or perhaps MiG-25PI) designation was allocated to an unbuilt proposed MiG-25 upgrade incorporating the N-019 Topaz radar of the MiG-29 (with a larger-diameter antenna). The new variant would also have had provision for R-27 (AA-10 'Alamo') and perhaps R-77 (AA-12 'Adder') missiles. However, it was felt that the missiles would have required modification for carriage at speeds much in excess of Mach 2, and, in any case, there were sufficient Su-27s available to make upgrading the old MiG-25PD unnecessary.

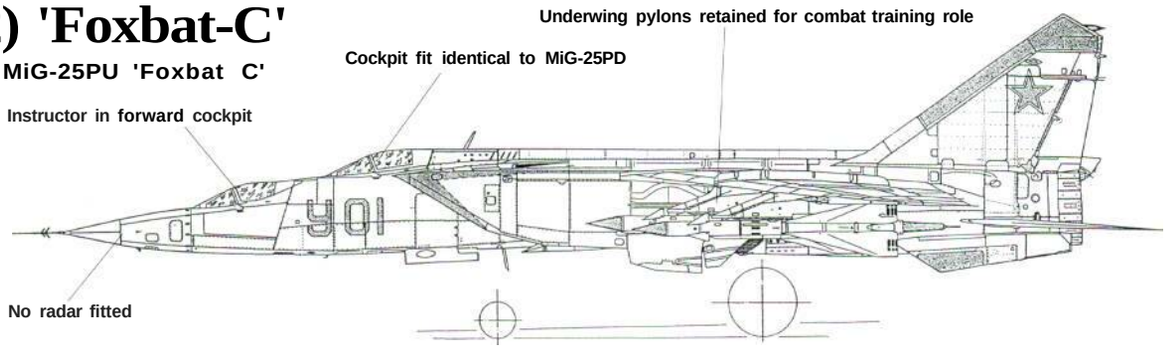
MiG-25PU (1-22) 'Foxbat-C'

Because the MiG-25P and MiG-25R fulfilled such different missions, and because their different mission equipment loads endowed them with different handling characteristics, separate two-seat trainer versions were produced of each basic type. Although the single-seat MiG-25P followed the single-seat MiG-25R into the air and into service, the two-seat interceptor trainer was finished before the reconnaissance trainer.

An initial aerodynamic trainer prototype (coded U01) was completed first, before a role-optimised MiG-25PU (I-22) was built and tested.

The MiG-25PU had no operational equipment or radar, and had an instructor's cockpit added in front of and below the normal cockpit. It was equipped with all the normal flying controls, but also had a sophisticated system to allow the pilot to generate simulated and synthetic failures, and even to run simulated intercepts, with synthetic targets, and the ability to simulate missile firings. The trainers were fitted with underwing hardpoints, and could (and sometimes did) carry dummy missiles underwing. On all but the first two-seaters, the instructor also controlled a command ejection system, allowing him to eject himself and the student pilot.

MiG-25PU 'Foxbat C'



Never-exceed speed was reduced to Mach 2.65, but otherwise the twin-sticker enjoyed much the same performance as the basic MiG-25P. MiG-25PU two-seat trainers were delivered to Algeria, Iraq, Libya and Syria.

Right: This MIG-25PU is one of those operated for trials tasks by the Zhukhovskii-based ***LII.***

Below: The 'Foxbat-C'had sideways-hinged cockpit canopies. Note also the black anti-glare surfaces.

Ye-133 'Foxbat-C'

A standard production MiG-25PU (coded 'Blue 53') was used to set a number of women's world speed and altitude records under the cover designation Ye-133. Piloted by Svetlana Savitskaya, the aircraft set a speed record of 2683.446 km/h (1,667.47 mph) over a 15- to 25-km (9- to 15-mile) course at unrestricted altitude. Next to fall was the women's altitude in horizontal flight record. On 31 August 1977 Savitskaya set a new record of 21909.9 m (71,882.87 ft). On 21 October 1977 the same pilot flew a 500-km (310-mile) closed circuit at 2466.31 km/h (1,532.54 mph), and on 12 April 1978 flew a 1000-km/h (621-mile) closed circuit at 2333 km/h (1,449.70 mph). Savitskaya was the daughter of Marshal Yevgenii Savitskii (Chairman of the State Commission for the MiG-25), and was also the women's world aerobatics champion.

MiG-25PU-SOTN'Foxbat-C'

A single MiG-25PU was converted to serve as a support aircraft for the Buran space shuttle programme. The MiG-25PU-SOTN *(Samolyot Optiko-Televisionnovo Nab/ydeniya* = aircraft, optical/TV surveillance) was modified for research into Buran trajectories and trajectory control and guidance, and for training Buran pilots and crew. It also served as a chase aircraft during Buran test flights, and augmented a trio of Tu-134LL testbeds used at low altitudes and low speeds.

The SOTN was equipped to film the Buran (or its analogues) during the descent. The aircraft had a Sony DXM-3P video camera in the front cockpit, a 3800PS video recorder, a DX-50 monitor and a KL-108 transmitter. The aircraft was fitted with a KRL-78 radio command link coupled to the standard SAU-155 autopilot, and to a B-218 datalink.

Before the Buran flew, the SOTN flew with a variety of Buran impersonators, from a MiG-25PU 'Red 02', a MiG-31 'Red 97', and the BTS-001 Buran horizontal flight test device. The SOTN lined up with the target at 18000 m (59,055 ft), then extended the gear and flaps, and throttled back to match the Buran's steep descent.

The aircraft flew a number of tests during 1985 and 1986, and then shadowed the Buran when it re-entered after its first and only (unmanned) space mission.

MIG-25PU (22040578) was modified to MIG-25PU-SOTN standard to act as a chase aircraft for the Buran programme.

Production reconnaissance versions

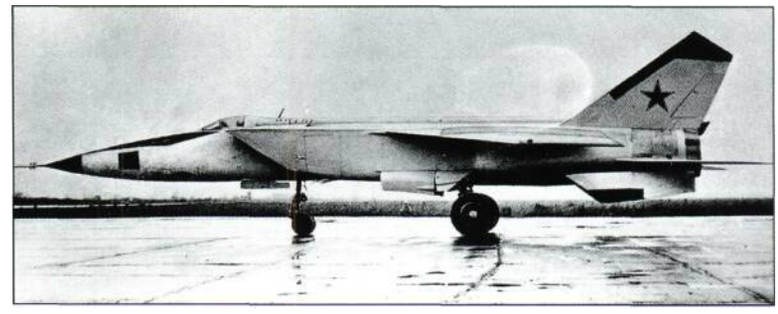
MiG-25R (I-02) 'Foxbat-E'[5]

The production MIG-25R had five Zenit cameras in the nose, located behind five optically flat camera ports. Four oblique A-70Ms were augmented by an A/E-10 topographic camera with a 1300-mm lens.

MiG-25Rs began rolling off the Gorkii production line in 1969, and deliveries to the VVS began soon after. The first aircraft delivered went to the Lipetsk training centre for training (there were still no two-seat trainers) and operational evaluation. Minor problems were soon corrected, and the production rate accelerated. The first front-line unit to re-equip was one squadron of a Guards reconnaissance regiment at Shatalovo near Smolensk, in the Moscow Military District. Front-line units tended to have one squadron of MiG-25s for high-level, clear-weather day reconnaissance, with Yak-27Rs and Yak-28s fulfilling the night and low-level reconnaissance duties. All but the earliest MiG-25Rs had the later, broader-chord tailfins, with reduced sweep on the trailing edge. The aircraft were also fitted with slightly longer nozzles than those fitted to MiG-25 interceptors, giving reduced drag, albeit with a tiny thrust penalty. From 020ST03, **MiG-25Rs** had plain wingtips (replacing the original endplate fins) and later-production MiG-25Rs had anti-flutter fairings.

All surviving MiG-25Rs were later modified to MiG-25RB standards.

This is the first production MIG-25R with the early style tail. The fintips of initial 'Foxbat-Bs' were more sharply cut down than those of their successors.



MiG-25RB (I-02B) 'Foxbat-B'

The MiG-25RB was developed as a direct result of a request from Egypt, which requested Soviet technical assistance for air defence, reconnaissance and strike duties. The Soviet government had already decided to deploy MiG-21s for air defence and MiG-25Rs for reconnaissance, and Defence Minister Marshal D. F. Ustinov requested that the MiG-25R also be adapted for high-level bombing.

The MiG-25R could already drop flare bombs, but they did not demand a high degree of accuracy. To give an acceptable level of accuracy, the RSBN-6 SHORAN was linked to the Peleng navigation system, while a new bomb ballistics algorithm was incorporated into the navigation computer.

Carrying bombs on the Mach 3 capable 'Foxbat' was not entirely straightforward, and required the design of a new heat-resistant multiple ejection rack and bomb shackles. Specially-modified, heat-resistant FAB-500M-62T HE bombs were developed for carriage by the MiG-25.

The fourth reconnaissance 'Foxbat', Ye-155R-4 (020SA01), was hastily converted at Akhtubinsk to serve as a trials aircraft. The flight test programme did not go entirely smoothly, however. It transpired that the wrong grade of solder had been used on electrical connections within the weapons pylons (unsurprisingly, it melted), and the pyrotechnic cartridges designed to release the bombs overheated and spontaneously exploded. Even before these faults were corrected, Aviard Fastovets scored a world first by dropping a bomb from 20000 m (65,616 ft) at 2500 km/h (1,554 mph).

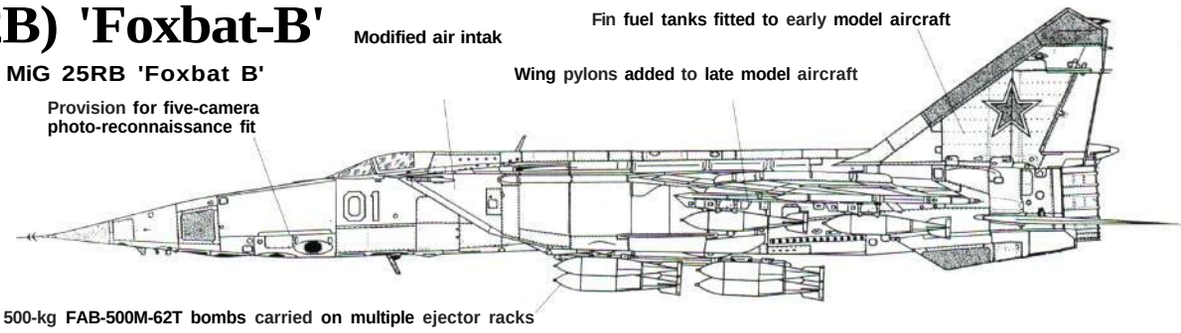
To maintain altitude performance, the upper surface area of the intakes was increased slightly. When modified, Ye-155R-4 demonstrated a 700-m (2,296-ft) increase in service ceiling, even with a full bomb load. The MiG-25RB also featured improvements to the aircraft's reconnaissance capability. The basic fit of A70M and A/E-10 cameras could be replaced by a pair of A-72 cameras with 150-mm lenses, or by a single A-87 camera with a 650-mm lens. The aircraft could carry SRS-4A, SRS-4B or SRS-4V Elint equipment, and an SPS-141 Siren ECM jammer. The generous provision of space and access hatches for all of this interchangeable equipment later made the aircraft a natural choice for test and development work.

'Production' MiG-25RB conversions were made at Gorkii, where a new Peleng D navigation complex was developed and incorporated. Following evaluation and testing at Akhtubinsk, production of new aircraft switched from the MiG-25R to the MiG-25RB, and MiG-25Rs already delivered were returned to the factory for conversion.

The MiG-25RB entered operational service in December 1970, initially with a VVS regiment based in the Ukraine. The first aircraft were limited to carrying four FAB-500 bombs under the fuselage (in place of a ventral tank) but the bomb load was soon doubled through the addition of underwing bomb carriage (one pylon below each wing). In the reconnaissance role, the MiG-25RB had a service ceiling of 23000 m (75,460 ft) and a mission radius of 920 km (571 miles), figures which were reduced to 21000 m (68,898 ft) and 650 km (404 miles) in the bombing role. In the reconnaissance role, the MiG-25RB could actually cruise above its service ceiling, decelerating but in level flight. The aircraft could exceed Mach 2.4 for 15 minutes, with speeds of Mach 2.65 to Mach 2.83 limited to five minutes. Cruising time at speeds of below Mach 2.4 was limited only by endurance. The last production MiG-25RBs (from 02022077) could carry 5000 kg (11,022 lb) of bombs, four FAB-500s in tandem pairs underwing, with six more under the fuselage.

The MiG-25RB remained in production well into 1972, and formed the basis for all subsequent reconnaissance variants. Improvements to the aircraft included the provision of successively upgraded navigation/bombing systems, 'Peleng DR' replacing 'Peleng D', before itself being replaced by 'Peleng DM'. The fin tanks were deleted during the mid-1970s.

MiG 25RB 'Foxbat B'



X-500

The X-500 designation was used as disinformation to cover four Soviet MiG-25s deployed to Egypt to provide reconnaissance of the Israeli military build-up. The MiG-25 was then still not in front-line service with the VVS, and the unit deployed to Egypt was specially formed, including front-line, Nil and even civilian test pilots. The 63rd Independent Air Detachment was deployed to Egypt in March 1971, with the aircraft being flown to Egypt aboard An-22s. The aircraft were partially disassembled, and were temporarily fitted with small MiG-21 wheels in order to gain cargo door clearance. The four aircraft consisted of two straight MiG-25Rs (020501 and 020504) and two aircraft converted to MIG-25RB configuration (020402 and 020601). They proved virtually immune to interception. The detachment returned to the USSR in July 1972, after about 20 missions over Israel (each flown by pairs of aircraft). MiG-25s returned to Egypt in October 1973, following the Yom Kippur War, and stayed until late 1974.

Above: Bulgaria was a little-known user of the MIG-25RB. Four aircraft were acquired, all MiG-25RBTs equipped with the Tangazh Elint system. One was lost in an accident and the others ultimately returned to the USSR.

Export MiG-25RB 'Foxbat-B'

The dual-role reconnaissance/bomber MIG-25RB (I-02B) was offered for export, concurrently with the export MIG-25PD. Bulgaria took delivery of four MiG-25RBs (and a MiG-25RU), becoming the only Warsaw Pact operator of the 'Foxbat-B', apart from the USSR. Algeria took an unknown number of MiG-25RBs with its MiG-25 fighters, Iraq and Syria each took eight, and Libya five (including 499 and 504). India (not an operator of MiG-25 fighters) received six MiG-25RBs (KP312, 351, 352, 353, 354 and 3106 equipping No. 102 Trisonics' Squadron, based at Bareilly). The Iraqi aircraft in particular saw extensive use in the bombing role, attacking Iranian targets during the long-running war between the two nations.

Right: The Indian Air Force took delivery of six MiG-25RBs and all wore the stylised eagle badge of No.102Sqn. OneoftheIAF's 'Foxbat-Bs' was written off in a crash, but the others are believed to all remain operational.

MiG-25MR 'Foxbat-B'

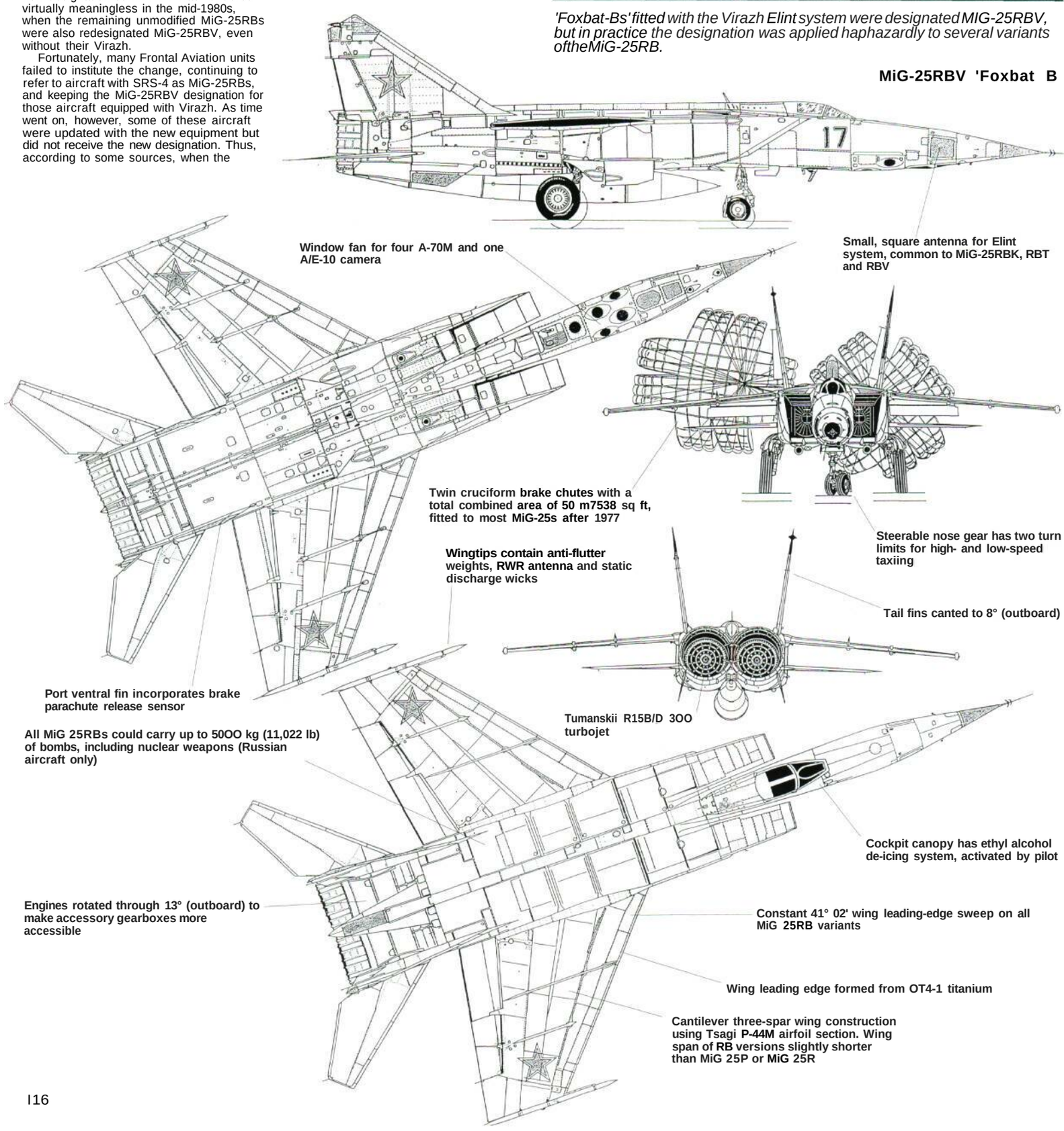
An unknown number of MiG-25RBs were converted to serve as weather/ meteorological reconnaissance aircraft, fitted with specialised sensors, but stripped of cameras and SRS-4 Elint equipment.

MiG-25RBV (I-02B) 'Foxbat-B'

MiG-25RBs were modernised with new SRS-9 Virazh (Izdelye 31) Elint equipment from 1978, gaining the new designation of MiG-25RBV. Most aircraft also had the new SPS-151 Lyutik (Buttercup) ECM jammer replacing SPS-141 Siren (Lilac). There was no external difference between the MiG-25RBV and the older MiG-25RB. The new designation suffix RBV was rendered virtually meaningless in the mid-1980s, when the remaining unmodified MiG-25RBs were also redesignated MiG-25RBV, even without their Virazh.

Fortunately, many Frontal Aviation units failed to institute the change, continuing to refer to aircraft with SRS-4 as MiG-25RBs, and keeping the MiG-25RBV designation for those aircraft equipped with Virazh. As time went on, however, some of these aircraft were updated with the new equipment but did not receive the new designation. Thus, according to some sources, when the Russians withdrew from East Germany the 931st ORAP at Werneuchen nominally retained MiG-25RBs, MiG-25RBVs and MiG-25RBTs, although all were probably MiG-25RBTs. The truth may never be known, since all the variants looked externally identical.

'Foxbat-Bs' fitted with the Virazh Elint system were designated MIG-25RBV, but in practice the designation was applied haphazardly to several variants of the MiG-25RB.



MiG-25RBVDZ 'Foxbat-E'

As with the interceptor MiG-25 (see MiG-25PDZ entry), serious consideration was given to fitting reconnaissance MiG-25s with inflight-refuelling probes. Two reconnaissance MiGs were fitted with inflight-refuelling probes for trials, one a MiG-25RBV, the other a MiG-25RBSh. The aircraft had similar probes to that fitted to the MiG-25PDZ, although they were mounted further forward. There is some controversy as to whether the aircraft's noses were stretched to accommodate the probes, and as to whether the probes were retractable, like that of the PDZ. The MiG-25RBV ('Red 68') was redesignated as the MiG-25RBVDZ, while the RBSh was redesignated RBShDZ. In the event, with the probe-equipped Su-24MR and Su-24MP entering service, the modification of MiG-25Rs with probes was not accorded a high priority.

The MIG-25RBVDZ development aircraft is seen here taking on fuel from an Ilyushin 11-78 'Midas' tanker, along with a Sukhoi Su-24M.

Close examination will reveal the probe on this MIG-25RBVDZ.

MiG-25RBN 'Foxbat-E'

A dedicated night photographic reconnaissance variant was designed alongside the MiG-25RB, but was destined to remain no more than a prototype. Fitted with two NAFA Mk 75 cameras produced by Kazan, the MiG-25RBN retained the standard reconnaissance nose, and carried up to 10 FOTAB-100 or FOTAB-140 photoflash bombs under the fuselage. Unfortunately, the photoflash bombs proved to be deadly weapons to anyone on the ground, in the vicinity. This severely restricted their use in peacetime training, and the photographic results were poor.

Confusingly, the MiG-25RBN designation has occasionally been used (perhaps unofficially, or perhaps erroneously) to describe some service aircraft. One such was 'Red 55', c/n 02016375 at Werneuchen, which was similar in configuration to the co-located MiG-25RBVs and RBTs, but which had only a single vertical camera port, reportedly covering a specialised night camera.

MiG-25RR 'Foxbat-E'

Eight MiG-25RBVs were modified by Mikoyan during 1969 to serve as high-speed, high-altitude radiation sampling aircraft, under the designation MiG-25RR *(Radiatsionnii* ***Razvedchik=rad\ai\or*** reconnaissance). The aircraft were fitted with sampling equipment, and received other modifications to maximise service ceiling. The MiG-25RRs were primarily used along the Chinese border between 1970 and 1980, keeping an eye on Chinese nuclear tests. The aircraft supplanted Yak-25RRs, Yak-25RRVs and Yak-28RRs, decreasing pilot exposure to radiation by flying through contaminated air more quickly. The MiG-25RR's radiation sampling equipment was upgraded while the aircraft was in service. Once their task was complete, the contaminated MiG-25RRs were scrapped.

MiG-25RBT (I-02T) 'Foxbat-E'

While the VVS MiG-25RBs were upgraded to MiG-25RBV, the Gorkii factory began production of a new reconnaissance derivative of the 'Foxbat', the MiG-25RBT. The MiG-25RBT was built from 1978, and had a Tangazh (Izdelye 33) Sigint package (in place of Virazh or SRS-4) and a Parol (Password) IFF set. The Tangazh set had receivers covering a wider range of hostile emitters, and sophisticated processing allowed post-flight emitter location using a form of triangulation. From 1980, these aircraft were fitted with the new LO-06 Beryoza (Birch) RHAWS instead of the Sirena S-3M. It is probable that some MiG-25RBs and RBVs were modified to MiG-25RBT standards, but it is uncertain as to whether such aircraft received the new designation, or whether they retained their original designations. Known MiG-25RBT construction numbers were 02020305 ('Red 61'), 020214146 ('Red 57'), 020214171 ('Red 53'), and 020216108 ('Red 56'), all serving with the 931st ORAP at Werneuchen. 02017745 ('Red 54') and 02016375 ('Red 55') were described as MiG-25RBVs, while the latter aircraft was also sometimes referred to as an RBN.

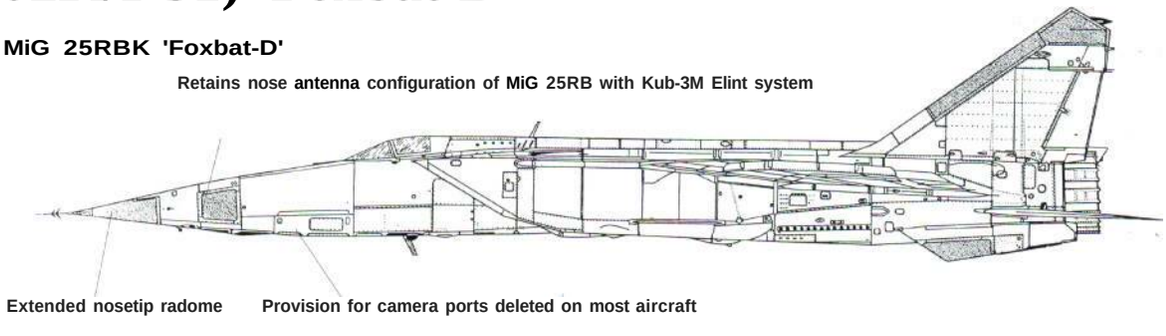
This MiG-25RBTwas one of the Welzow-based aircraft which returned to Russia in 1992.

MiG-25RBK (I-02K/I-51) 'Foxbat-D'

The success of the MiG-25R and MiG-25RB led to the development of dedicated Elint and radar reconnaissance versions of the MiG-25R 'Foxbat-B', based on the MiG-25RB airframe. The MiG-25RB could already carry SRS-4 Elint equipment on removable pallets, but could not transmit data to the ground as it was received, and thus required lengthy post-flight evaluation and debriefing. The MiG-25RBK was designed to remedy this shortcoming, and used the heavier and more bulky Kub-3M Elint suite, which had to be permanently installed. This necessitated removal of most of the camera mounts, while the dielectric panels on the sides of the nose were just slightly enlarged. Although it lacked the very long dielectric panel of the MiG-25RBS, the RBK's lack of camera windows made the aircraft a 'Foxbat-D' in NATO's eyes, rather than a 'Foxbat-B'. Another change was made to the dielectric radome at the tip of the nose. It was longer, extending somewhat further aft, and had a cut-out in the upper section.

With no possibility of a Kub-equipped MiG-25 being used in the photo-reconnaissance role, all the remaining camera ports were finally deleted. The aircraft retained the bombing capability of the MiG-25RB 'Foxbat-B', however, and was fitted with SPS-143 ECM equipment, rather than the more common SPS-142.

MiG 25RBK 'Foxbat-D'



The MIG-25RBK was produced at Gorkii from 1971 until 1980.

The MIG-25RBK formed the basis of the MiG-25RBF, which was produced by conversion from 1981, mainly at VVS maintenance units.

Production of the MIG-25RBK was undertaken at the Gorkii factory from 1971 until 1980. Like all members of the RB family, the MiG-25RBKhas few major distinguishing features. This aircraft has a curious mix of camera ports along with the RBK's trademark extended nose.

M/G-25 *and MiG-31 Variants*

MiG-25RBF (I-02F) 'Foxbat-D'

The MiG-25RBF designation was applied to MiG-25RBK aircraft upgraded with new Shar-25 (Balloon-25) Elint equipment and a modernised defensive aids system, with improved RWRs and chaff/flare dispensers. The aircraft were not officially known as the MiG-25RBSh, since this designation was already taken by those MiG-25RBSs upgraded with the Shompol SAR. In service, however, the MiG-25RBSh designation was sometimes used erroneously. The only external distinguishing feature of the RBF lay in the provision of four small rectangular dielectric panels low on the sides of the nose, in a similar position to the camera ports. The MIG-25RBF was produced by conversion of existing MiG-25RBKs, mainly at WS maintenance establishments. It retained full bombing capability. The new Elint equipment worked quite well at low level, and a small number of MiG-25RBFs received a camouflaged finish, like that applied to some MiG-25BMs. Known MiG-25RBF construction numbers were 02024604 ('Red 59'), 02024819 ('Red 58'), 02029095 ('Red 60'), 02029105 ('Red 62'), and 02032317 ('Red 38'), all serving with the 931 st ORAP at Werneuchen.

*The MIG-25RBF did away with the camera provisions of earlier **RB** variants. Instead, the nose was fitted with two pairs of dielectric panels for its Shar-25 Elint system.*

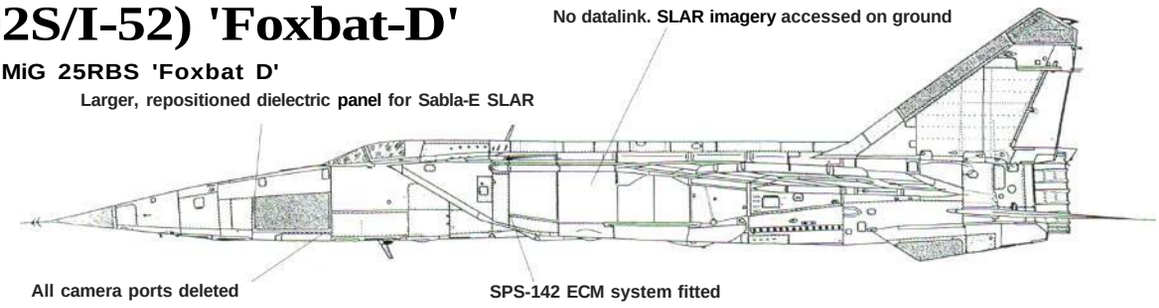
MiG-25RBS (I-02S/I-52) 'Foxbat-D'

The MiG-25RBS was developed at the same time as the MiG-25RBK, and, while retaining the bombing capability of the MiG-25RB, dispensed with provision for interchangeable camera and Elint fits. Instead) the aircraft was fitted with a powerful Sabla-E (Sabre-E) Sideways Looking Airborne Radar (SLAR), which was used at altitudes of 17000 m (55,774 ft) or more. The MiG-25RBS had a distinctive external appearance, with huge rectangular dielectric panels on the sides of the nose, through which the SLAR 'looked'. They were reminiscent of the long SLAR antennas further forward on the noses of the first Ye-155Rs, but deleted from subsequent reconnaissance aircraft. The MiG-25RBS had no oblique camera ports, but did retain the shorter dielectric nosecone of the original reconnaissance version.

The SLAR's imagery was recorded for interpretation in a special mobile ground station, and was detailed enough for recognition of static aircraft, ships and armoured vehicles, and for surveying the condition of buildings or bridges in a post-strike reconnaissance role. Most surviving MiG-25RBSs were converted to MiG-25RBSh standards from 1981.

Large flat panel antennas for a Sideways-Looking Airborne Radar (SLAR) were fitted on both sides of the MiG-25RBS's nose.

MiG 25RBS 'Foxbat D'



MiG-25RBSh (I-02SH)

The MiG-25RBSh designation was applied to MiG-25RBs modified by the VVS to carry the new Shompol (Ramrod) SLAR. The new equipment had two or three times better resolution than the old SLAR over a given range, and could be used effectively at heights between 300 and 23000 m (985 and 75,460 ft). Furthermore, the new SLAR had a superb mapping mode, and had a genuine MTI (Moving Target Indication) capability. The modification from MiG-25RBS to MiG-25RBSh standard brought with it no change to the aircraft's external appearance. It seems likely that virtually all surviving MiG-25RBSs were brought up to the new standard, although in service some may have retained their original designation. Where MiG-25RBFs equipped with Shar were in service, and already being unofficially referred to by the MiG-25RBSh designation (as at Werneuchen), the Shompol-equipped aircraft were referred to by their original MiG-25RBS designation.

Upgraded MiG-25RBSh aircraft fitted with the Shompol SLAR were virtually indistinguishable from original MiG-25RBSs.

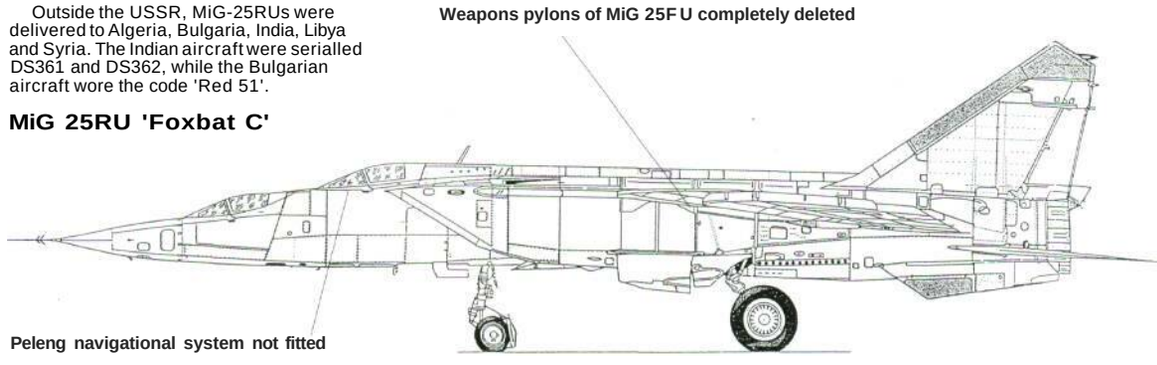
MiG-25RU (1-39) 'Foxbat-C'

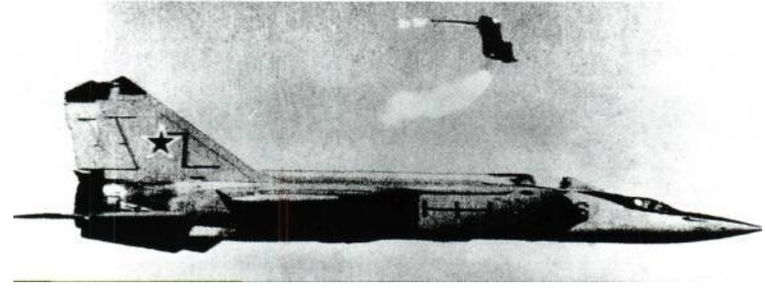
Although the decision was taken to develop separate trainer variants for the interceptor and reconnaissance MiG-25s, both trainer types were essentially based on the airframe of the MiG-25P, with cranked wing leading edges, no tailfin fuel tanks, and short engine nozzles. The MiG-25RU was thus externally identical to the MiG-25PU, although it lacked provision for underwing stores pylons. The only real difference lay in the fact that the MiG-25RU had the MiG-25R navigation system, and instructor-controlled reconnaissance equipment simulators.

The MiG-25RU prototype (390SA01) made its maiden flight on 20 March 1971. This aircraft (coded 'Red 46' and later 'Blue 01') was later used by the Lll at Zhukhovskii as a testbed for the Zvezda K-36RB ejection seat designed for the Buran space shuttle.

Outside the USSR, MiG-25RUs were delivered to Algeria, Bulgaria, India, Libya and Syria. The Indian aircraft were serialled DS361 and DS362, while the Bulgarian aircraft wore the code 'Red 51'.

MiG 25RU 'Foxbat C'





Above: Two-seat 'Foxbats' were attached to every MiG-25 unit and were heavily used. Most airframes now have high fatigue times.

Above right: 'Red 46' was an ejection seat testbed for the Bur an project It was later renumbered as 'Blue 01'and now serves with the ill.

Right: India operates a pair ofMiG-25RUs alongside its MiG-25RBs.

SEAD Versions

Ye-155K

The performance of the MiG-25 was sufficiently impressive to prompt air force chiefs to consider using the platform to meet a number of other roles. Early generation Soviet anti-radiation missiles were too big and too heavy to be carried by tactical aircraft, but the Kh-58 (AS-11 'Kilter') was suitable for carriage by the MiG-25. When the MIG-25RB was accepted into service, the directive from the Council of Ministers included a clause calling for that aircraft to be fitted with Kh-58s. This did not actually happen, of course, but development of a dedicated SEAD variant gathered pace.

Although the proposed Ye-155B bomber was abandoned before much work could be completed on it, the defence suppression Ye-155K programme absorbed a great deal of effort and did eventually lead to flying hardware. The Ye-155B had been planned as a two-seater, with an Ivolga (Golden Oriole) electro-optical sighting system for day/night target detection and acquisition. The Ye-155K was originally planned as a fairly similar type, but was envisaged as a single-seater with a new targeting system consisting of a pair of Landish (Lily of the Valley) ECM sets.

MiG-25B

In 1977, Mikoyan proposed a dual-role reconnaissance/defence suppression variant of the 'Foxbat', the MiG-256, with an Espadron reconnaissance strike complex including Shornpql SLAR, a thermal imaging system, a new Elint set, and anti-radiation missiles. The successful trials of the MiG-25BM prototype led to the abandonment of the dual-role concept, and no MiG-25B prototype was ever constructed.

MiG-25BM (I-02M) 'Foxbat-F'

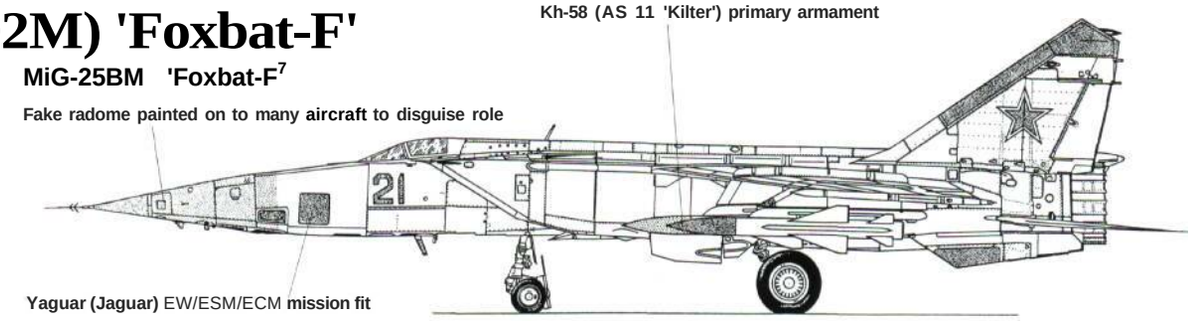
The Ye-155K programme eventually bore fruit in the shape of the MiG-25BM, though this, the first 'Wild Weasel' MiG-25, was destined not to enter service until 1988. The MiG-25BM was developed as a dedicated defence suppression aircraft, intended to clear a path through heavily defended airspace for reconnaissance MiG-25s and other aircraft types. The aircraft was fitted with a sophisticated and comprehensive Jaguar integrated ECM and targeting system, capable of detecting, locating, selecting and prioritising threats and of defining launch zones for the aircraft's four Kh-58 anti-radiation missiles. The Kh-58 missile itself was heavily modified before it entered service with the MIG-25BM, gaining a new rocket motor and a new empennage to make carriage by other aircraft types easier. The new missile variant was designated as the Kh-58U *(Unifitsirovannii* = standardised). As well as passive, multi-band receivers, the MiG-25BM's equipment package included a Sych-M (Little Owl) radar.

The prototype MiG-25BM was converted from a MiG-25RBV airframe during 1976. The aircraft was then tested, firing real Kh-58 missiles (with telemetry equipment instead of warheads). With no synthetic, simulated radar transmitters available, the missiles were fired against real, 'live' radars, which were switched off at the last moment to try to save them from destruction. In most cases, though, the Kh-58 simply continued to go where it had been homing, scoring many direct hits.

Fewer than 100 MiG-25BMs were built, between 1982 and 1985. They were delivered to Frontal Aviation units already operating MiG-25RBs, usually forming dedicated SEAD squadrons within a regiment. The MiG-25BM featured a 20-cm (7.8-in) nose plug giving extra volume for ECM and missile guidance equipment. The aircraft entered front-line service in 1988, following successful service trials and an extended service ground and aircrew training period. MiG-25BMs replaced Yak-28 sub-variants in Frontal Aviation service.

Most MiG-25BMs had their noses painted in dark grey or dark green around the area which equated to the MiG-25P's radome, in a deliberate attempt to make them look like fighters to the casual observer. MiG-25BMs in East Germany and Poland were withdrawn when the Berlin wall came down, to cloak them from the eyes of curious Westerners. The type remains extremely secret, to this day.

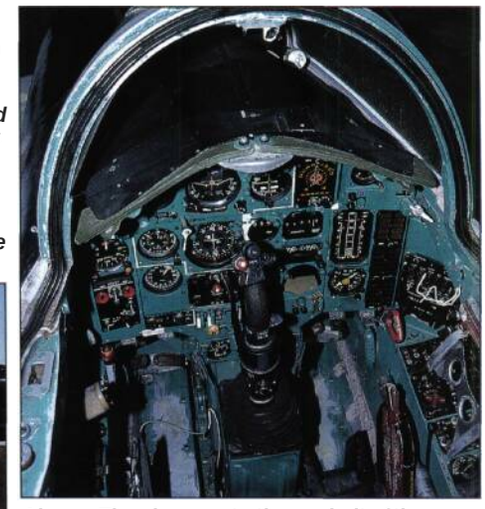
MiG-25BM 'Foxbat-F[7]



Left: This is the first MiG-25BM, which was rebuilt from a MIG-25RBV, in 1976.

Above: This Poland-based BM is seen on display with a full missile load.

This view (left) of an undisguised MIG-25BM used for trials shows some of its specialist antenna fit. Compare it with the service aircraft below.



Above: The changes to the cockpit of the MiG-25BM are limited to the addition of revised mission equipment panels.

The MiG-31 'Foxhound' family

Ye-155MP-unbuilt versions

The development of stand-off and escort jammers and of cruise-missile-carrying low-level bombers made reliance on ground-based radar and controllers increasingly untenable. The USSR began replacing its battlefield air superiority fighters with aircraft which were more capable of autonomous operation (in the form of the MiG-29 and Su-27), and, at much the same time that these projects were launched, Mikoyan began to develop a new derivative of the MiG-25 for the PVO which would have similar autonomous capabilities. The Ye-155MP was intended to patrol the vast areas of the USSR where ground-based and airborne early warning coverage was patchy, and had a long endurance and range, with a dedicated backseat crewman operating the radar to enhance the aircraft's ability to operate without guidance from ground-based controllers.

Although other design bureaus produced studies of new-generation interceptors, Mikoyan was favoured by the PVO, who wanted an aircraft derived from the tried-and-trusted MiG-25. The requirement originally called for an increase in maximum speed (to 3500 km/h; 2,174 mph) as well as increased range and endurance. These requirements proved quite impossible to meet - engines powerful enough to improve performance were too thirsty to allow any increase in range, while bypass turbofans with better specific fuel consumption could do no better than to maintain the MiG-25's existing performance.

This variable-geometry Ye-155MP configuration featured a strange mix ofMiG-23, MiG-25 and MiG-31 features.

Three different Ye-155MP configurations were drawn up by Mikoyan to meet the requirement. All were founded on the baseline MiG-25 fuselage and retained the MiG-25's raked intakes, although they were refined. The designs were all designed as two-seaters, with pilot and navigator sitting in separate tandem cockpits under upward-hinging canopies. The most strikingly new configuration featured a MiG-23-type variable-geometry wing, a single tailfin and a folding twin ventral fins, with four-wheel main undercarriage bogies.

The second Ye-155MP variant was known as the Izdelye 518-55, and was the closest in appearance to the eventual production MiG-31. The aircraft had a three-spar trapezoidal wing with leading-edge root extensions, semi-submerged underfuselage missiles and tandem twin-wheel main undercarriage units.

Finally, the Ye-158 was a tailless Delta with an ogival wing, reportedly similar to that of the Tu-144 and A-144 Analog. At 30 tonnes, this aircraft was lighter than the original MiG-25, and was reportedly similar in configuration to the Mikoyan MiG 1.42.

Izdelye 518-55 combined airframe features of the MiG-25 and MiG-31, with an all-new wing and double bogie main undercarriage.

The Ye-155MF* (F=Frontovoy, *front-line) was a high-speed attack design, with a side-by-side cockpit arrangement, similar to the Su-24.

MiG-25MP (1-83) (Ye-155MP)

The production MiG-31 (originally known as the MiG-25MP) was based on the configuration of the 1-518-55. The aircraft was designed from the start to incorporate a pair of Soloviev D-30F turbofans (as tested in the I-99) and the Zaslon (Shield) radar (previously the Smerch-100) intended for installation in the MiG-25PA.

This was the first electronically scanned phased array radar in front-line service, and could scan an area out to 70° on each side of the centreline, and to 60° below the nose. The radar could track 10 targets, and could simultaneously engage four. The system was designed to allow the aircraft to act as a mini-AWACS, guiding other fighters whose own radars could be in standby mode, not emitting. Alternatively, relatively small formations of MiG-31 s would be able to sanitise a huge swathe of airspace. The radar was backed up by a retractable IRST.

The basic configuration was translated into reality by a team led by the great Rostislav Belyakov, whose experience and ability ensured that despite its designation and overall appearance, the MiG-25MP was much more than a simple derivative of the MiG-25. The fuselage and air intakes (which might superficially appear to have been unchanged) were of entirely new structure, housing more fuel and acting as a 'lifting body' which generated some 25 per cent of the total lift. The wing, too, was entirely redesigned. The two-spar structure of the MiG-25 gave way to a thinner, cambered, three-spar wing of much greater stiffness. The camber delayed tip-stalling, while small LERXes enhanced controllability at high Alpha. The previously fixed leading edge was given four-section flaps, while the plain flaps and two-section ailerons of the MiG-25 were replaced by two-section flaps and outboard flaperons.

The undercarriage was of entirely new design, with tandem staggered mainwheels on a single oleo. The front wheels were inboard of the oleo, with the rear wheels outboard. This ensured that the rear wheels did not simply follow the front wheels when taxiing on snow, preventing them from slipping or skidding on ice compressed by the front wheels. This system was lighter and more compact than a four-wheeled bogie, which was felt to be the best alternative.

'Blue 831' was the first Ye-155MP prototype. The two development aircraft did not have a smooth test and trials programme, delaying the service introduction of the MiG-31.

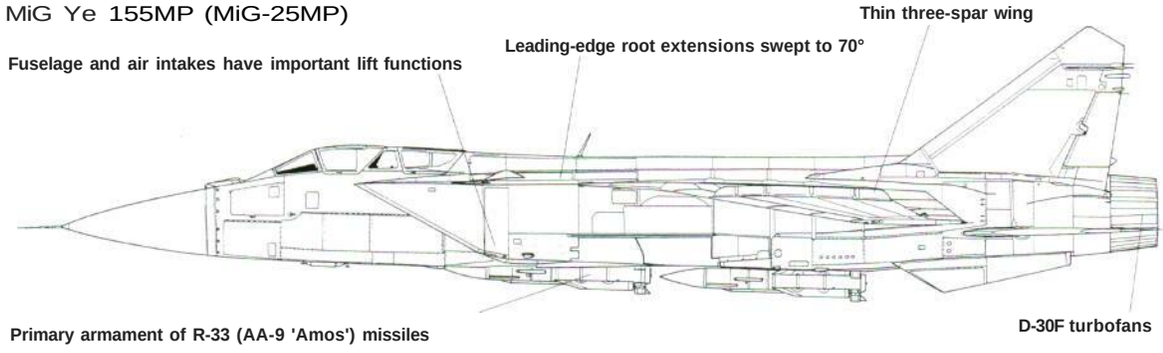
The navigator's cockpit incorporated a telescopic control column, rudders and a retractable periscope, allowing the operational aircraft to be used for pilot conversion training, and also giving the backseater a chance of recovering the aircraft in the event of pilot incapacitation or injury. This meant that there was no need for a dedicated two-seat trainer version of the MiG-31.

Unlike the MiG-25, the MiG-25MP was designed to have an internal gun, a 30-mm GSh-6-23 revolver cannon similar in concept to the US M61A1 Gatling-type Vulcan cannon. It was mounted in a fairing scabbed to the side of the starboard engine nacelle. The MiG-31 's primary weapon was similarly new. The R-33 missile used inertial guidance for the early stage of its trajectory (with course correction from the launch aircraft) before going to active radar homing in the terminal phase. This made the weapon broadly comparable to the similar-looking AIM-54 Phoenix carried by the F-14 Tomcat, although the Western missile was reported to have a very much longer range. There are persistent reports that the R-33 was designed as a direct result of Soviet access to Phoenix missiles supplied to Iran.

The MiG-31 could also carry R-40 missiles underwing, but, when it did so, the number of R-33S carried had to be reduced by one to allow the carriage of a datalink/illuminator pod. Alternatively, underwing pylons could be fitted with launch rails for short-range IR-homing weapons like the R-60 (AA-8 'Aphid').

Two MiG-25MP prototypes were built in the OKB's own workshops. The first (coded 'Blue 831') made its first flight on 16 September 1975, in the capable hands of Fedotov. Initially completed with a plain nosewheel door, the aircraft was soon fitted with a replacement door which incorporated three landing and taxi lights. The second prototype ('Blue 832') flew in May 1976, piloted by Ostapenko. The second aircraft had a representative avionics fit, including radar, and was fitted with the type's built-in cannon. Despite a host of minor problems, the type showed such promise that it was immediately ordered into production as the MiG-31.

MiG Ye 155MP (MiG-25MP)



MiG-31 'Foxhound' (I-01)

Production of the MiG-31 began at Gorkii in 1977. The aircraft differed from the two prototypes in detail, although they looked identical. Undercarriage doors and airbrakes were redesigned, as were the wing fences and LERXes' D-30F-6 engines fitted to the production aircraft were similarly modified and refined, as was the NO-07 SBI-16 Zaslon radar. Initial MiG-31 production batches were very small, and the aircraft produced were used for development, trials, test and evaluation work. There were only two aircraft in the first batch ('Blue 011', c/n 0101 and 'Blue 012', c/n 0102), with three more in the second batch ('Blue 201', c/n 0201, 'Blue 202', c/n 0202, and 'Blue 203', c/n 0203). 'Blue 305' (0305/69700T04801), the 10th production aircraft, introduced structural strengthening.

The MiG-31 entered the IA-PVO inventory in May 1981, although the official Act of Acceptance was not signed until December, and front-line service did not begin until 1982. The MiG-31 's flight test programme and initial service life was marred by engine and fuel system problems, with a number of losses. Fortunately, the MiG-31 soon settled into service, with conspicuous success. The MiG-31 has equipped PVO interceptor regiments at Anadir, Andirma (72nd IAP), Gromovo (180th IAP), Jelizovo, Monchegorsk (174th IAP), Morshansk (153rd IAP), Nachodka, Pravdinsk (786th IAP) and Talagi (518th IAP). NATO's ASCC allocated the codename 'Foxhound' to the new interceptor.

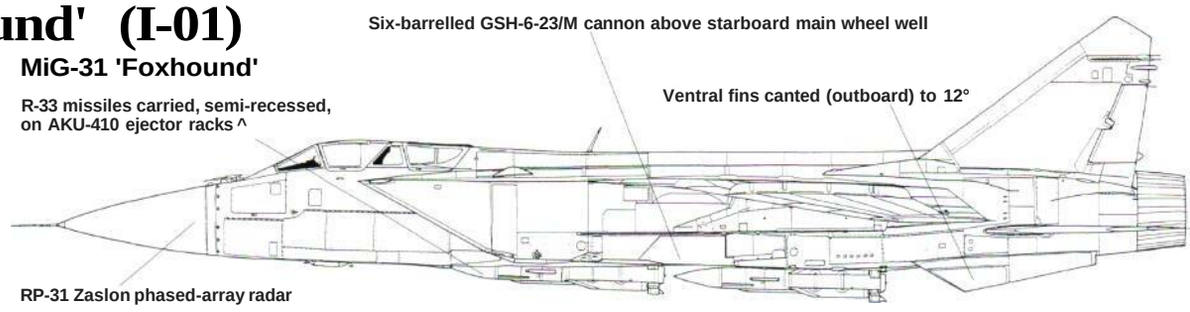
Unlike the MiG-25, the MiG-31 could carry two underwing fuel tanks (each with up to 2500 litres/550 Imp gal) under the outboard underwing pylons, although there was no provision for a belly tank.

Some production MiG-25s have appeared to lack segmented 'petals' on the jetpipe of one (usually the port) or both engines. The reason for this has never been satisfactorily explained.

The MiG-31 's avionics suite includes an SPO-15SL RHAWS, SRO-2P and SRZ-2P IFF transmitter and receiver, and an SO-69 ATC transponder. For communications, the aircraft has an R-862 UHF, an R-864 HF and an APD-518 secure digital datalink. It also has a BAN-75 command link. The NK-25 navigation suite includes a duplicated IS-1-72A INS, an A-331 SHORAN, A-723, Marshroot and Tropik LORAN sets.

The new configuration was originally intended to form the basis of a family of front-line aircraft, and not just an interceptor. Thus the Ye-155MF was a dedicated SEAD aircraft based on the MiG-31 B (1-01B).

MiG-31 'Foxhound'



Above: The MiG-31 is built from a mix of stainless steel, aluminium and titanium alloys.

Right: 'Blue 202' is an example of the second production batch of MiG-31s. Its predecessor, 'Blue 201', crashed in 1984.

Above: Despite the many problems suffered during its development programme the MiG-31 has had a successful service career, proving reliable and popular. It was the world's first production interceptor to be fitted with a phased-array radar.

Above right: The (dummy) IR-homing R-46TD (AA-6) missiles carried by this 'Foxhound' are an unusual load for the type.

Right: Operational MiG-31 units are largely based at frontier air bases, in inhospitable conditions. This Siberian-based aircraft is seen taxiing out for a mission with a mixed warload of R-33 and smaller R-60 missiles.

MiG-31 (I-01DZ)

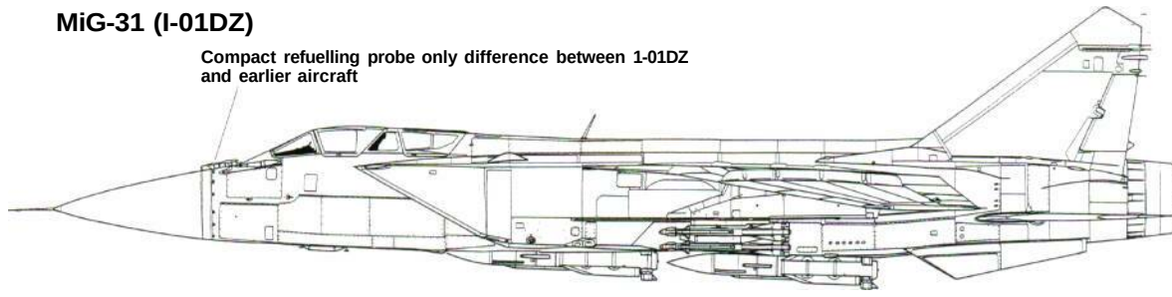
Operational experience soon showed that the MiG-31 was deficient in range, although it did represent a major improvement over the aircraft it replaced. To a certain extent, the MiG-31 was a victim of its own success, since when it became clear that its range and endurance exceeded those of the MiG-25, air force and naval commanders began to request that MiG-31 s perform other missions, including the escort of long-range maritime reconnaissance aircraft.

The obvious solution was to provide an inflight-refuelling probe. Building on the experience gained with the probe-equipped MiG-25 variants (MiG-25PDZ, MiG-25RBVDZ, and MiG-25RBShDZ), Mikoyan added a neat semi-retractable probe in front of the cockpit, offset well to port. The aircraft was also fitted with a 'micro-control system', using displacements of nozzle petals to give fine control during refuelling contacts.

One aircraft (c/n 1603) was fitted with a dummy probe for trials, and was joined by c/n 3608 with a fully-functioning probe, though without all the necessary navigation and fuel transfer monitoring equipment designed for the production installation. The first fully-equipped 'probed' MiG-31 was 'Blue 592' (c/n 5902), which was fitted with LORAN and other long-range navaids. This aircraft was used for a range of long-range demonstration flights, including nine-hour flights and practice intercepts over the magnetic North Pole, testing the aircraft's nav system sensitivity to magnetic anomalies.

Forty-five MiG-31 s (including 'White 374', c/n 3704, seen at many Western air shows) were built to this standard (between 1990 and 1991) and were sometimes unofficially known as MiG-31 Ds before production switched to the further improved MiG-31 B.

MiG-31 (I-01DZ)



The addition of a refuelling probe to the MiG-31 was a logical step and the DZ (Dozaprvka, refuelling) modification greatly extended the combat radius of the 'Foxhound'.

Apart from their semi-retractable probes (semi-recessed but uncovered and visible when retracted), these aircraft did not differ from the standard MiG-31.

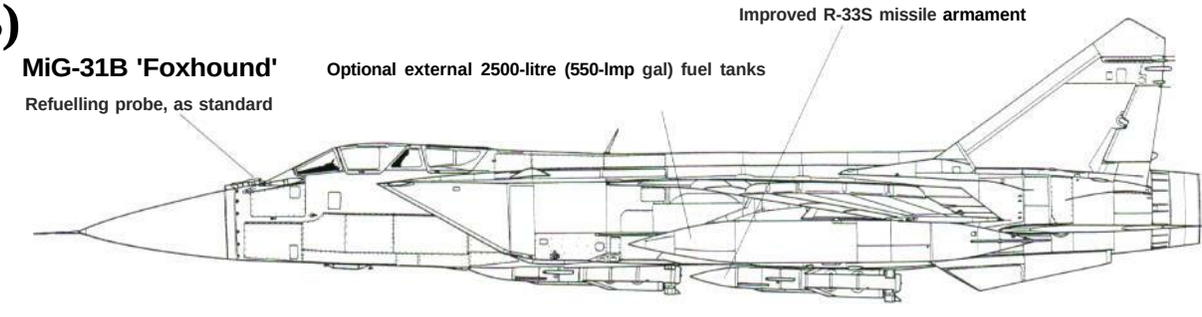
MiG-31B (I-01B)

Just as Victor Belenko's 1976 defection provoked the development of the MiG-25PD 'Foxbat-E', another Russian renegade (Tolkachev) sold state secrets to the West, including details of the radar and fire control systems of various front-line fighters, including the MiG-31.

Mikoyan was already working on an upgrade to the MiG-31, and this was given an added impetus by the compromising of some of the original aircraft's secrets. Tolkachev was arrested by the KGB in 1985. Under the designation MiG-31 B, the aircraft gained an improved radar (with better electronic counter-countermeasures capability), upgraded R-33S (AA-9 'Amos') air-to-air missile armament and improved avionics, including some new digital processors. All MiG-31 Bs were otherwise built to so-called 'MiG-31 D' standards, with enhanced navigation equipment and inflight-refuelling probes.

The MiG-31 B entered production at Gorkii in 1990, as MiG-31 D production began to run down. Existing MiG-31 s were upgraded to the same standard as the MiG-31 BS.

MiG-31B 'Foxhound'



MiG-31BS (I-01BS)

The MiG-31 BS (*Stroievoi* = operational) designation was applied to early production MiG-31 s (and MiG-31 Ds) upgraded to full MiG-31 B standards at Gorkii. These aircraft were normally modernised when they returned to the factory for routine maintenance, repair or overhaul. After modification, they were externally identical to new-build MiG-31 Bs. Numerically, the MiG-31 B and MiG-31 BS were the most important types in the IA-PVO inventory, although they may now have been overtaken by the various Su-27 sub-types in service.

Below: The MiG-31 B/BS was a stepping stone from the first 'Foxhounds' to the MiG-31M. The improved aircraft was fitted with upgraded mission electronics and more capable R-33S missiles.

MiG-31LL

A single unprobed early MiG-31 ('Red 79') has been converted for test duties at the Ill at Zhukhovskii. The aircraft is externally virtually standard, although it does have unusual wingtip fairings which contain mountings for test cameras for filming stores separations. Some sources suggest that the aircraft has also been used for ejection seat tests. The aircraft wears with camera calibration markings, and even has a bald lion (Lysii Lev) insignia on its intakes.

The ill's sole MiG-31LL has small bullet fairings on its wingtips, housing test cameras.

MiG-31F

This designation was applied to a multi-role tactical fighter derivative of the MiG-31 B revealed at the 1995 Paris Air Salon. While retaining the Zaslon radar and R-33 AAM capability, the MiG-31 F was also compatible with a range of air-to-ground weapons, using new radar modes or TV/laser guidance.

Maximum take-off weight of the MiG-31 F was increased to 50 tonnes, allowing the aircraft to carry a maximum air-to-ground weapon load of 9000 kg (19,840 lb) on six hardpoints. The aircraft could operate as a 'Wild Weasel' defence suppression platform, carrying Kh-31P or Kh-25MP missiles. Other weapons carried by the type could include the Kh-29, together with TV- or laser-guided bombs.

MiG-31E

The MiG-31 E (1-01 BE) designation was originally applied to a straightforward (slightly downgraded) export version of the MiG-31 B, with less than full-standard ECM, simplified R-33 missiles and a downgraded radar. A prototype ('White 904') has been tested at Akhtubinsk, and another may be 'White 903'. A number of nations have been associated with the possibility of MiG-31 exports, including China, Iran and Syria. The same designation now applies to a slightly more ambitious export version of the MiG-31, with the ground attack capability of the MiG-31 F and with provision for some Western avionics and weapons systems. The original single-role export MiG-31 E is believed to have been abandoned.

Gorkii MiG-31/hybrid MiG-31M

The Gorkii factory built one MiG-31 aircraft with a number of modifications and 'improvements' designed by the plant's own engineers. The resulting aircraft, coded 'Blue 503', had the bulkheads between some of its fuel tanks deleted, saving weight but causing a shift in the centre of gravity, with unacceptable effects on performance and handling.

This airframe was subsequently used as a testbed for the MiG-31 M programme, fitted with a new MiG-31 M forward fuselage, and modified with a MiG-31 M spine, but retaining 'normal' LERXes and fin fillets. It is not certain whether the aircraft was re-engined. It was never a true MiG-31 M, although it used the 'Blue 051' code which would have been associated with the first MiG-31 M prototype, had the first M airframe not been a static test airframe.

MiG-31M (1-05)

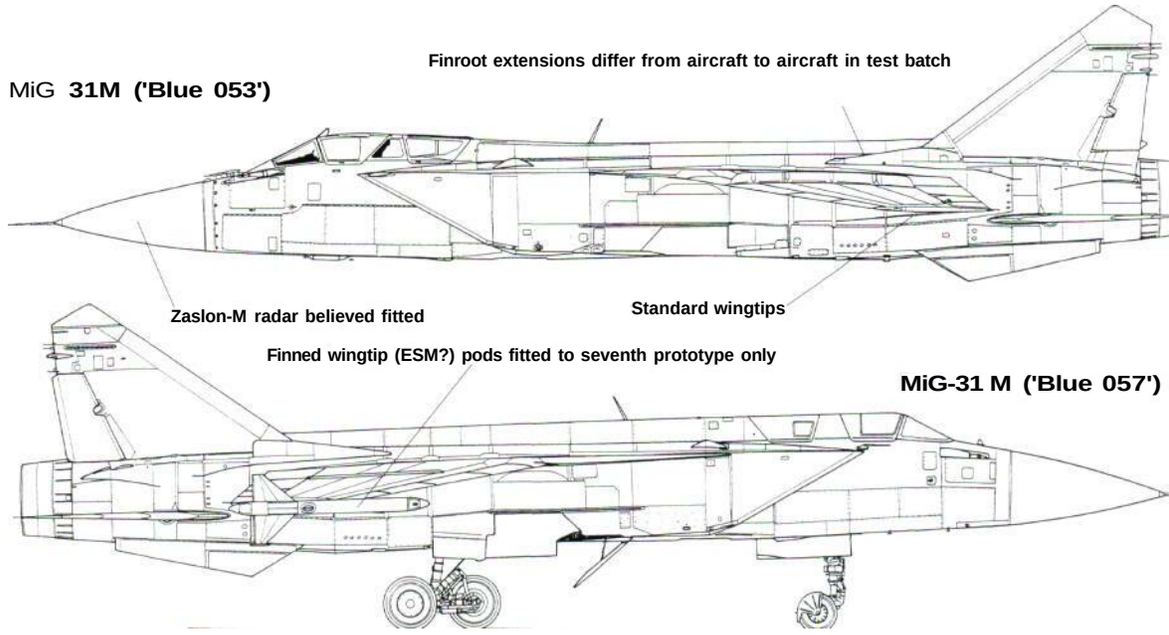
The MiG-31M designation was applied to the most advanced version of the 'Foxhound' yet seen. The new variant was primarily designed to exploit the longer-range R-37 missile, which had a claimed reach of up to 300 km (186 miles). In April 1994 a MiG-31 M armed with an R-37 demonstrated at least one successful intercept against a very long range target (destroying a drone at a range of 300 km/ 186 miles). Whereas the basic MiG-31 carried four missiles in tandem side-by-side pairs, the MiG-31 M had a more cluttered belly, with three side-by-side recesses, each housing a tandem pair of the new missiles. Similar in size and appearance to the original R-33, the new R-37 missile is almost certainly a direct derivative of the baseline MiG-31 's 'Phoenikskii'.To them could be added up to four of the formidable new R-77 (AA-12 'Adder') missiles underwing. The gun was deleted.

To take full advantage of its new missile, the MiG-31 M was fitted with an entirely new radar (possibly based on the existing Zaslon) with a larger-diameter radome (necessitating a wider and deeper nose). The radar was augmented by a revised IRST and a laser rangefinder. To improve the pilot's view forward over the nose, the nose in front of the cockpit was drooped by 7°. The MiG-31 M was fitted with a range of new avionics systems, and the rear cockpit was extensively redesigned, with new CRT multi-function display screens. Interestingly, the rear cockpit lost its throttles and telescopic control column, and, with no provision for flying the aircraft from the backseat, the forward-looking periscope was removed, and the canopy over the rear cockpit became more solid, losing windows. This made the rear cockpit environment darker, improving the backseater's view of his display screens in strong sunlight. By contrast, the front cockpit canopy was entirely redesigned, losing its centreline frame, and the original heavily-framed windscreen with its separate quarterlights was replaced by a single, one-piece wrap-round screen.

The MiG-31 M had a bulged fuselage spine, housing new avionics equipment and some extra fuel. Other visible airframe modifications included the provision of enlarged LERXes with sabre-like curved leading edges. Similarly, the rudders were of increased chord, yet the tailfin trailing edge below the rudder was cut away, improving airflow around the rear fuselage. The fin fillets were also refined. Although the MiG-31 M retained an inflight-refuelling probe, it was redesigned, with an integral cover that was more fully submerged when retracted, and was relocated on the starboard side of the nose With a considerably heavier maximum take-off weight, the MiG-31 M gained a new, more powerful engine, the D-30F-6M.

The MiG-31 Ms were built in the Gorkii factory. The first airframe was for static test, and the first flying prototype was thus the second airframe, coded 'Blue 052'. It made its maiden flight on 21 December 1985 but crashed before it could be fitted with its radar, and was replaced by the rebuilt aircraft originally produced to test modifications designed by Gorkii's own engineers (see separate entry). All of the MiG-31 M prototypes differed from each other in detail, but looked almost identical. The exception was 'Blue 057', the seventh and final MiG-31 M. This aircraft incorporated a pair of fixed wingtip ECM/ESM pods, with triangular upper and lower finlets.

The MiG-31 M had the misfortune of being born at the wrong time, when defence budgets were being slashed. As the aircraft reached an advanced stage of flight testing, the money simply ran out. Today, the MiG-31 M programme seems to be 'dead in the water'.



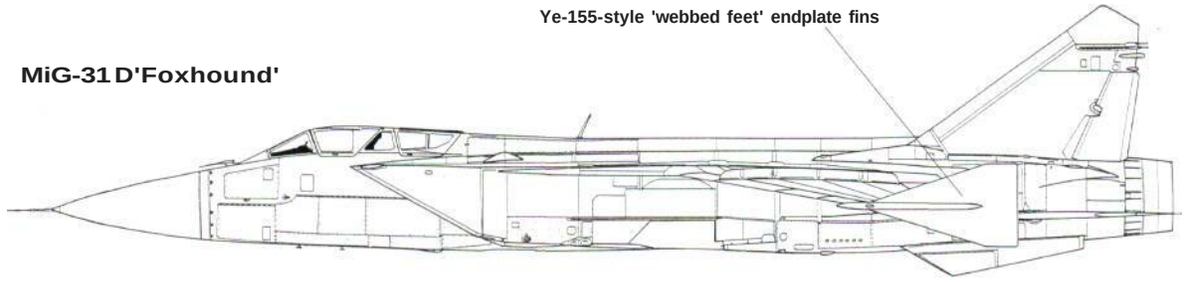
The MiG-31M introduced an even more sophisticated radar fit and improved R-37 missiles to the basic 'Foxhound'. A family of development aircraft was built; 'Blue 056' with dummy R-77 missiles (above) and 'Blue 057' (below) with its distinctive wingtip pods are seen here.

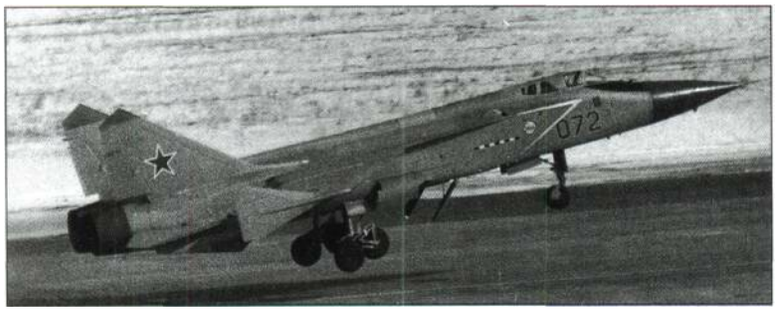
MiG-31D (1-07)

Two MiG-31 D prototypes were built in 1987, coded 'Blue 071' and 'Blue 072'. They used the MiG-31 D designation officially, unlike the first probe-equipped MiG-31 s, which were sometimes unofficially known as MiG-31 Ds. The MiG-31 D may have been based on the MiG-31 M, probably using the MiG-31 M's D-30F-6M engines and certainly featuring the same long, curved LERXes. On the other hand, the MiG-31 D had the original small spine, and the same cockpit canopies and 'undrooped' nose radome.

These highly-specialised aircraft had the standard weapon system removed, and had no underfuselage missile recesses. This was because the aircraft were designed simply as carriers for a single example of an advanced anti-satellite missile, and were optimised to get this weapon to its high-altitude 'edge of space' launch envelope as soon as possible. The aircraft featured new wingtip fairings with triangular endplate fins similar to those fitted years before to the earliest Ye-155 aircraft. These finlets, known as 'flippers', improved directional stability when carrying the enormous centreline missile. The aircraft had no gun.

The MiG-31 D prototypes were probably not fitted with radar but any production version would almost certainly have had some kind of search radar fitted.





Above and left: The 'true' MiG-31 D was intended to be the launch platform tDr an anti-satellite weapon, much like the USAF's F-15/ASM-135A ASAT combination. The endplate 'flippers' were added for high altitude stability.